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Title: A year in the life of a LANL secondee: HE gas gun experiments at TA-40

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# **A year in the life of a LANL secondee: HE gas gun experiments at TA-40**

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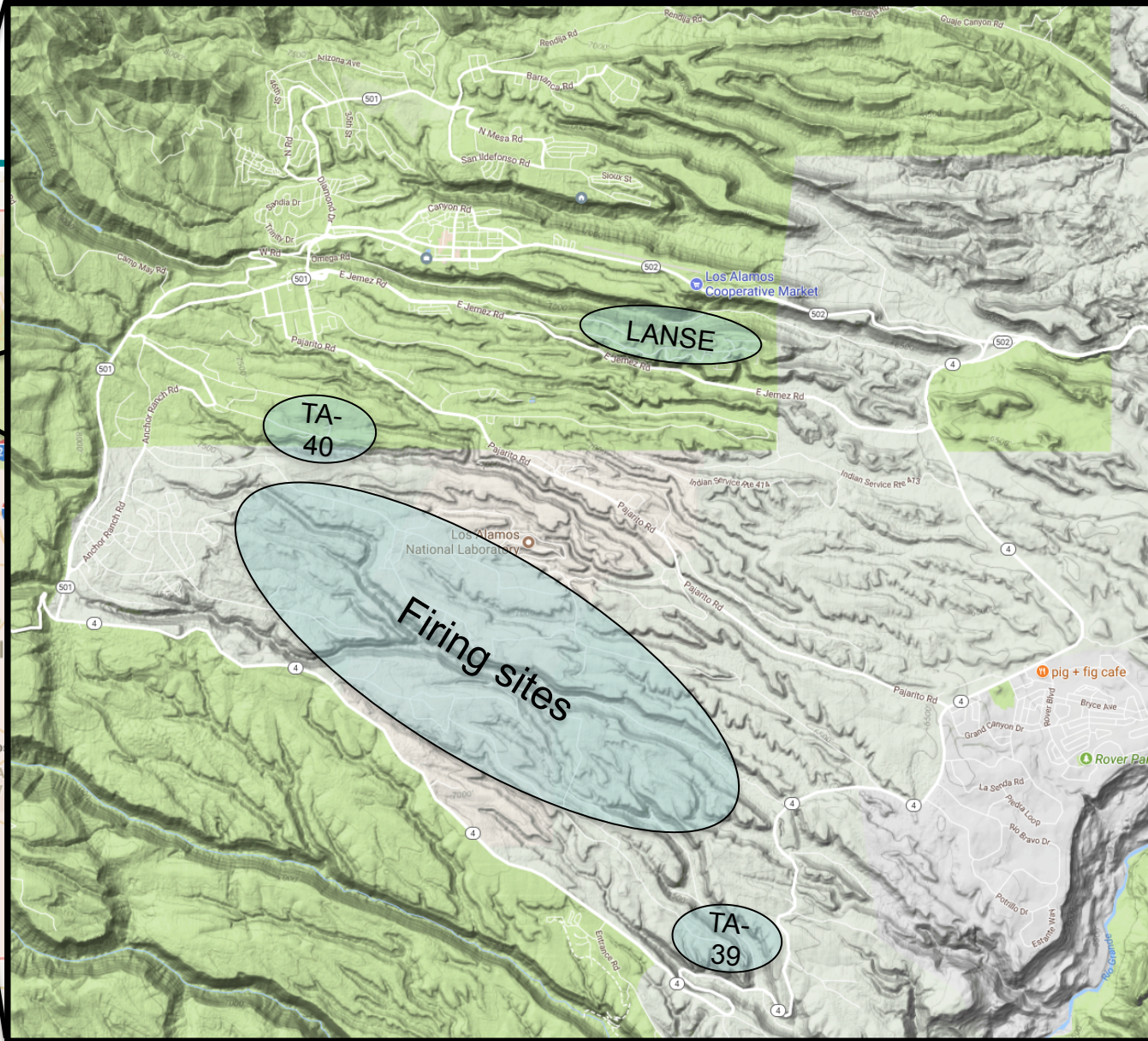
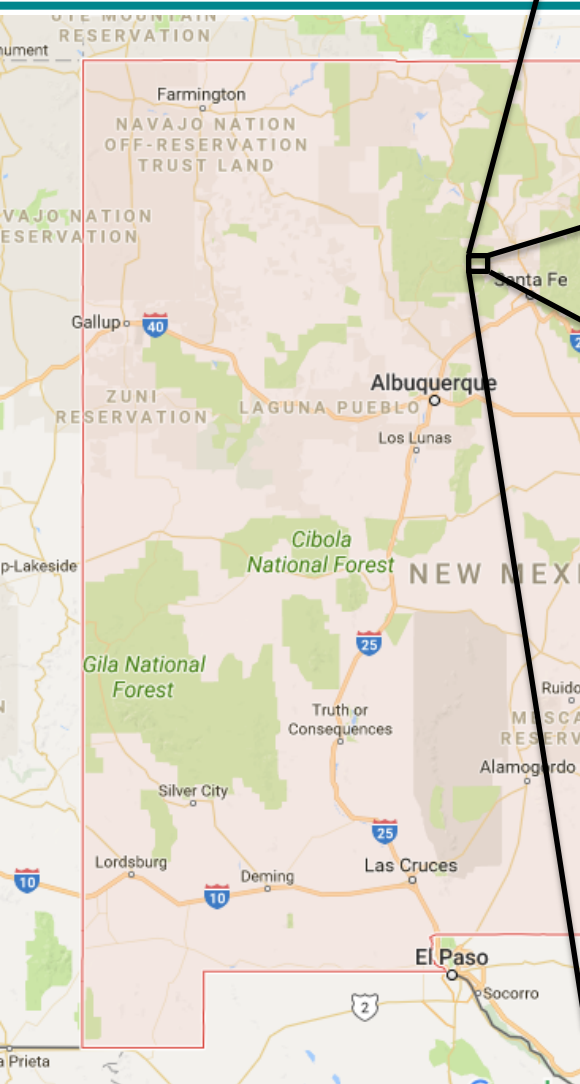


# Contents

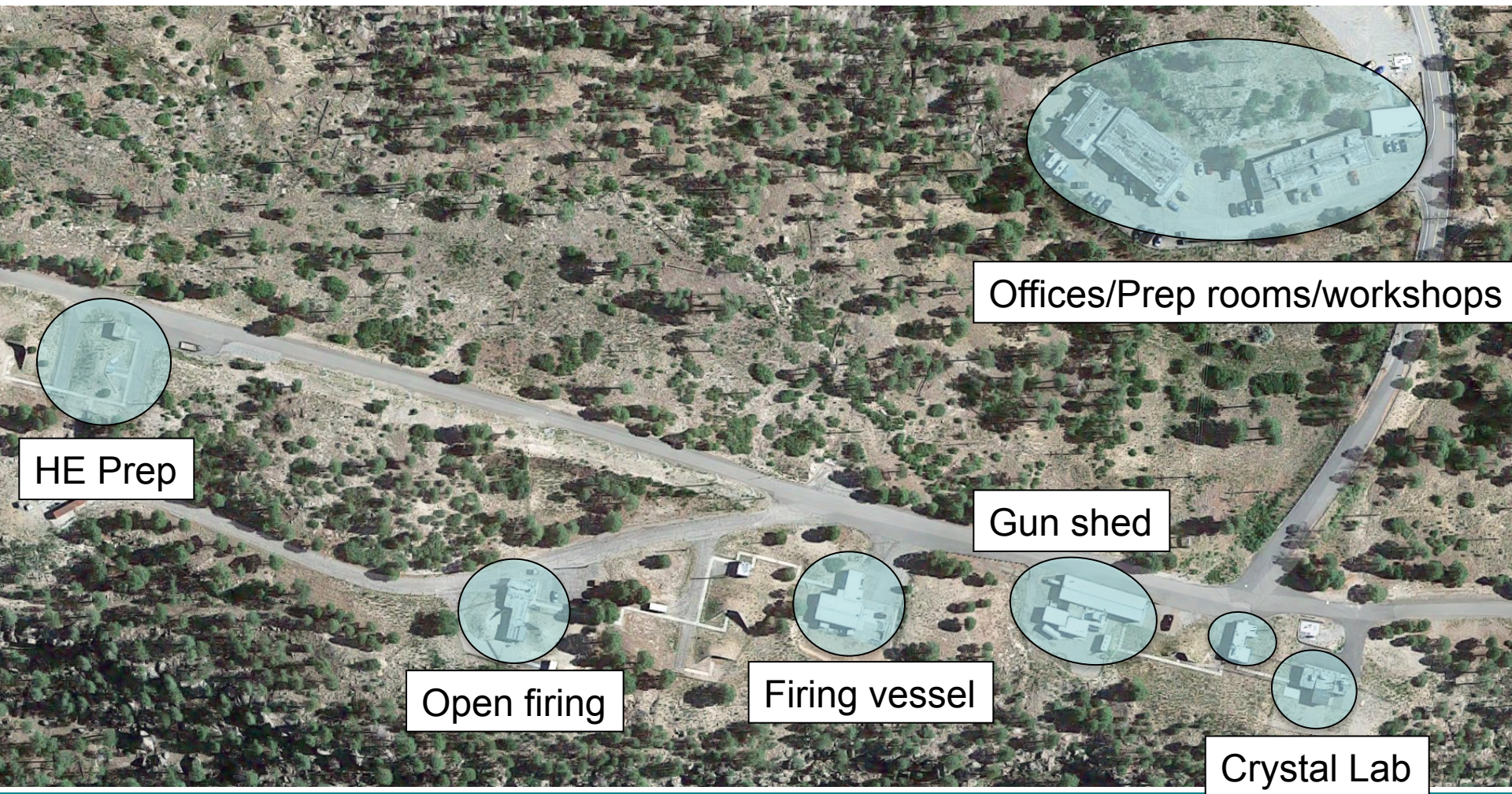
- Where have I been hiding?
- Comp B
- Ring up induced shock initiation
- Liquid NM
- Shallow Angle
- Overdriven

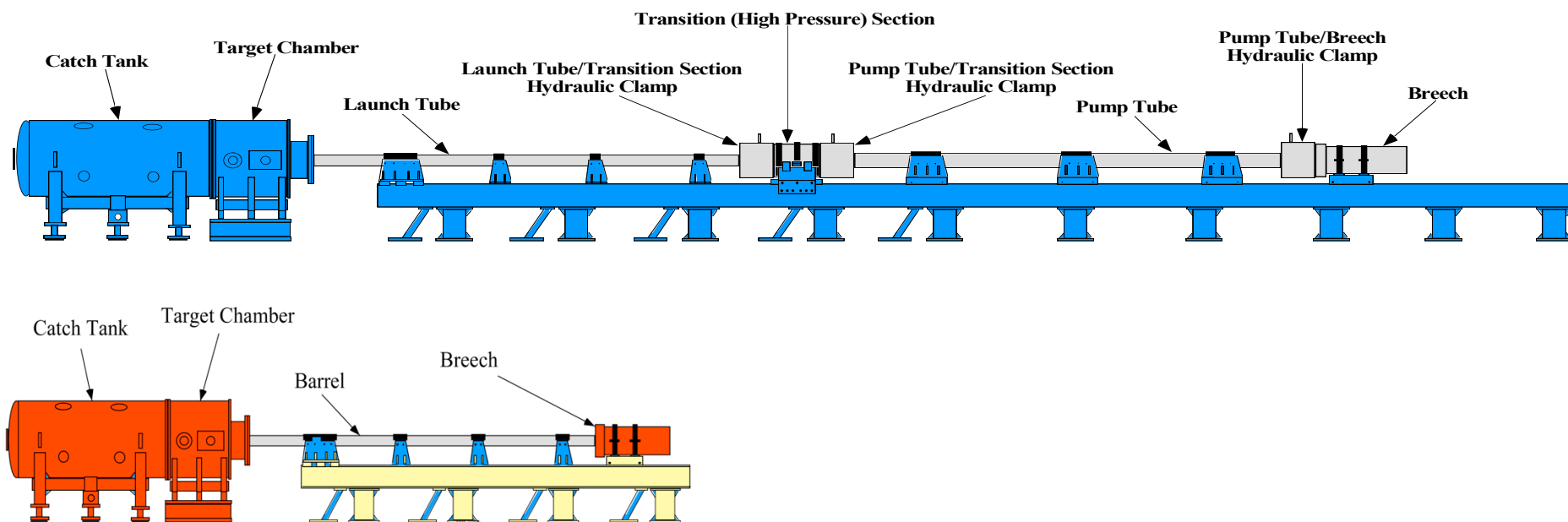
# NNSA Labs





# TA-40 (M9 - Shock and Detonation Physics)



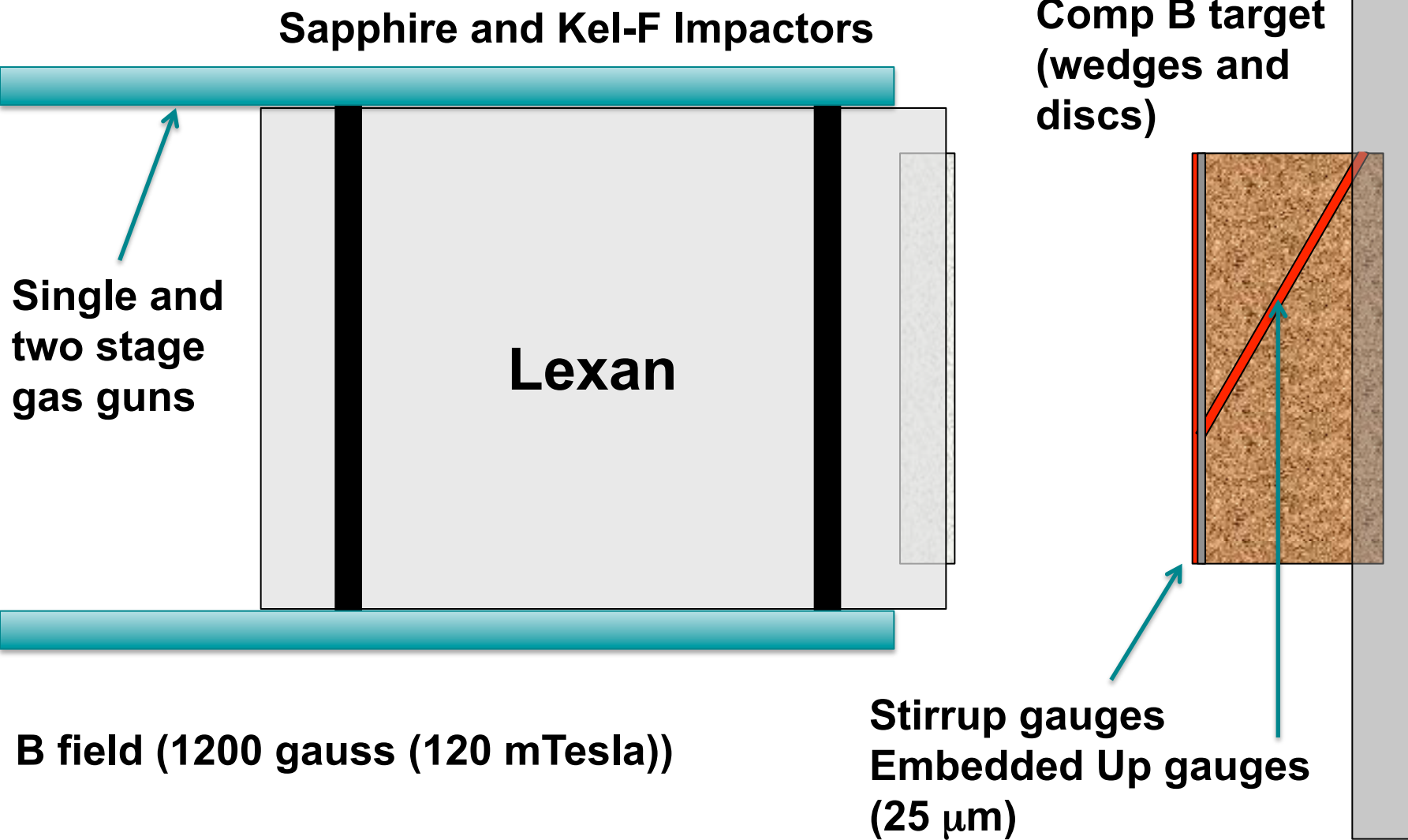


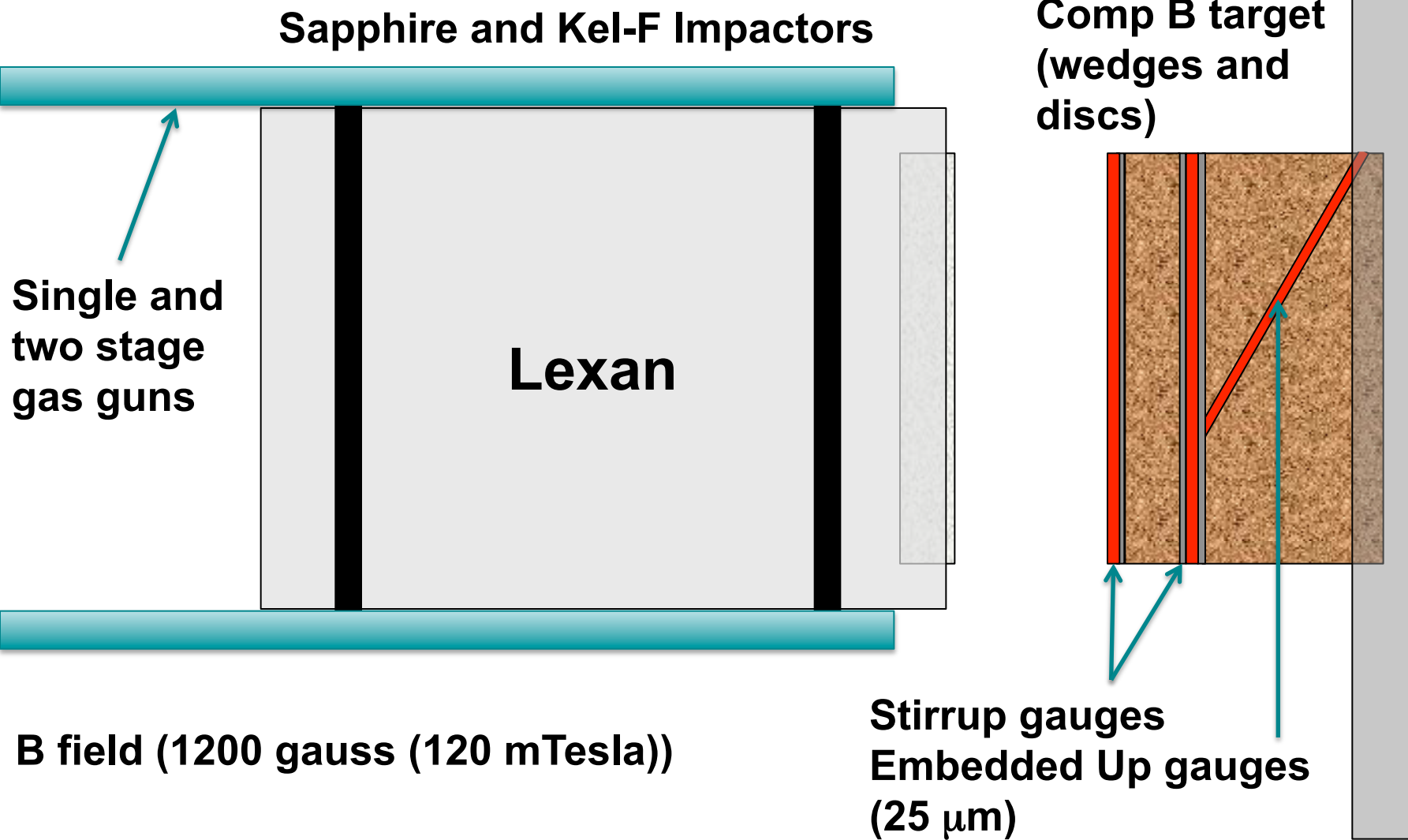
Gun	Gas	Max Breech Pressure (PSI)	Launch Tube diameter (mm)	Velocity Range (km/s)	Target Chamber Vacuum (mTorr/mbar)
Single	He	5,000	72	0.1 to 1.1	50 / 0.07
2 Stage	He	15,000	50	<1 to 3.6	50 / 0.07

# YEAR ONE

## Comp B

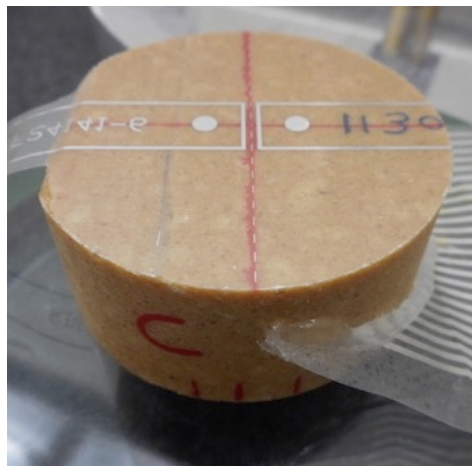
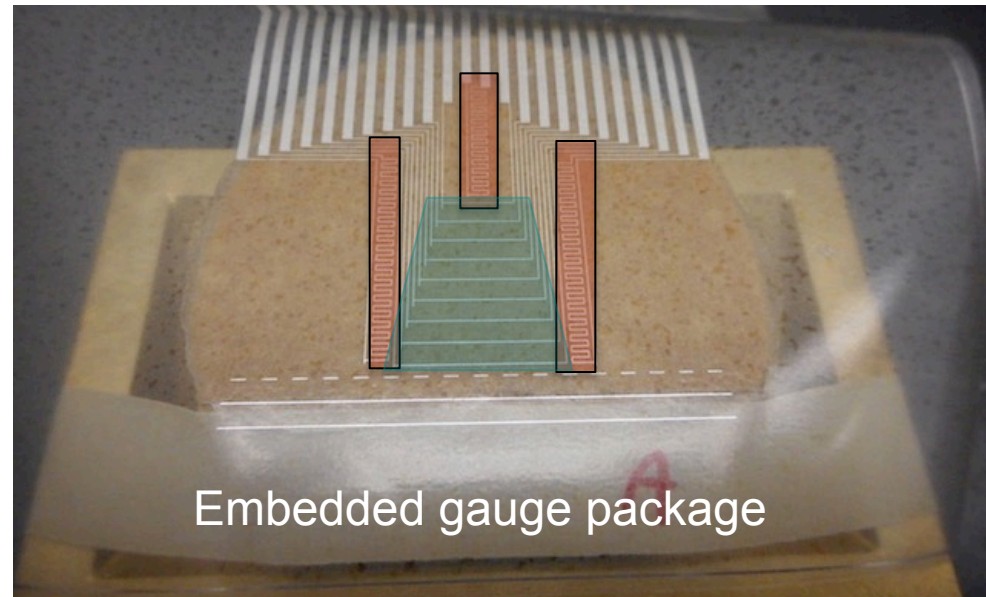
- UK hot isostatically pressed Comp B
  - 59.5/39.5/1 RDX/TNT/Wax
  - Density  $\sim 1.701$  g/cc (US 1.71 g/cc)
- 7 Sustained Pulse Gas Gun shots
  - Wave profiles, Pop plot, Hugoniot...
  - ...CREST model
- 3 short shock shots
- 2 low pressure Hugoniot shots



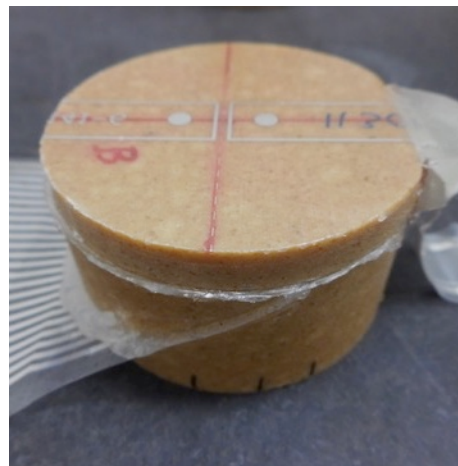


# Shot Setup

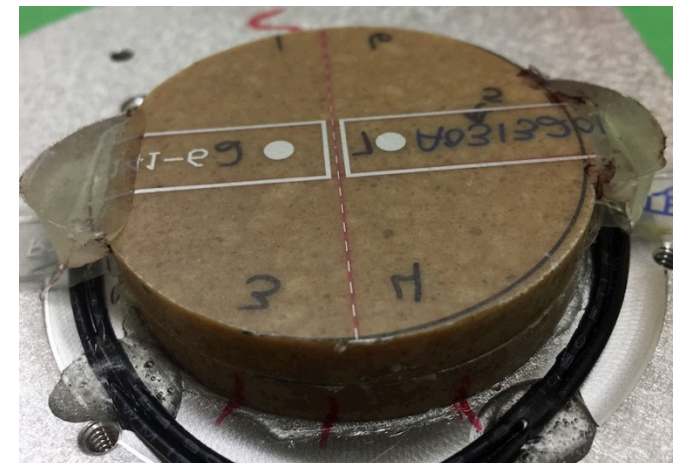
- 9 Embedded Gauges
- 3 Tracker Gauges
- 1 (or 2) Stirrup Gauges



Standard Target

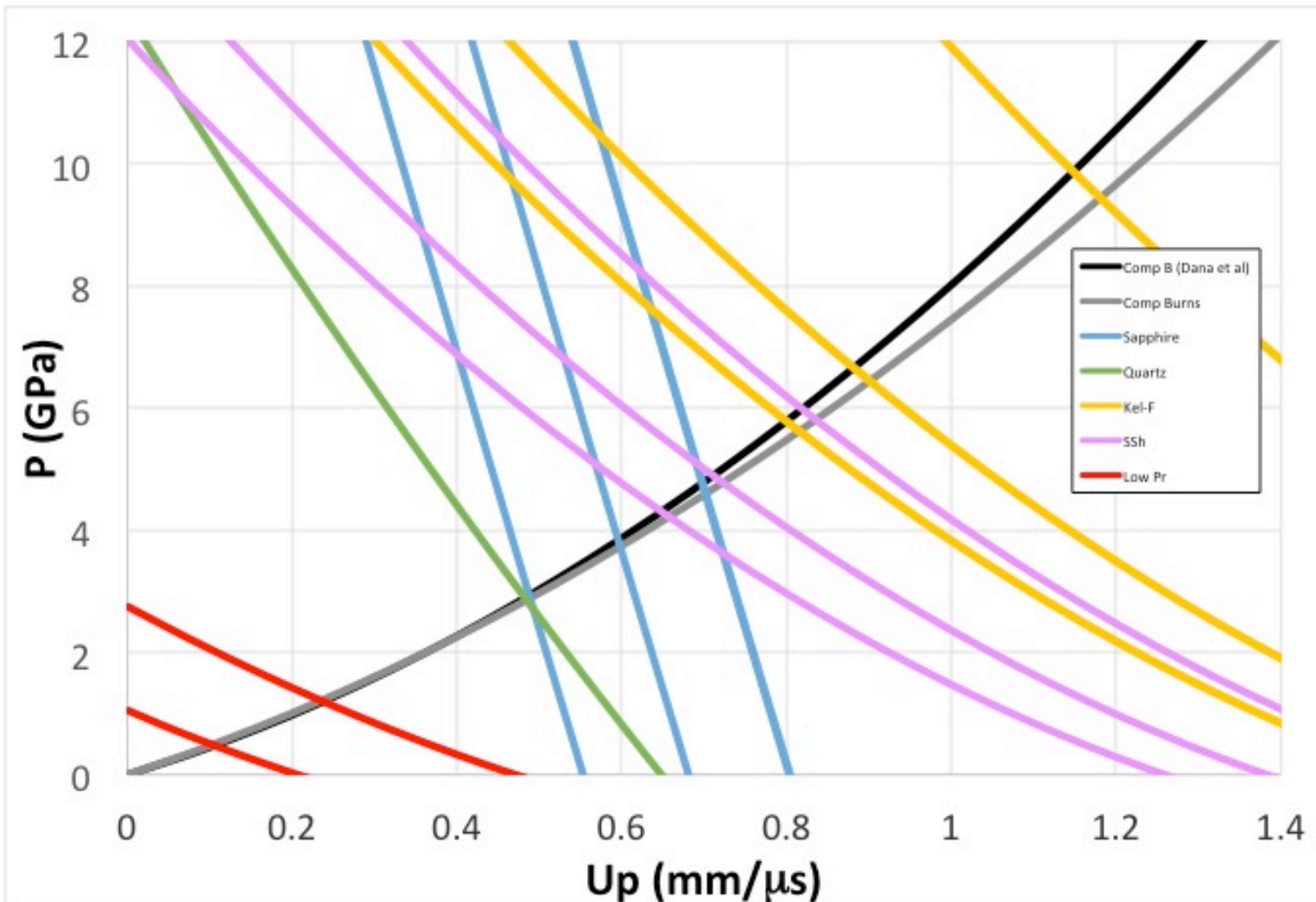


Longer run distance

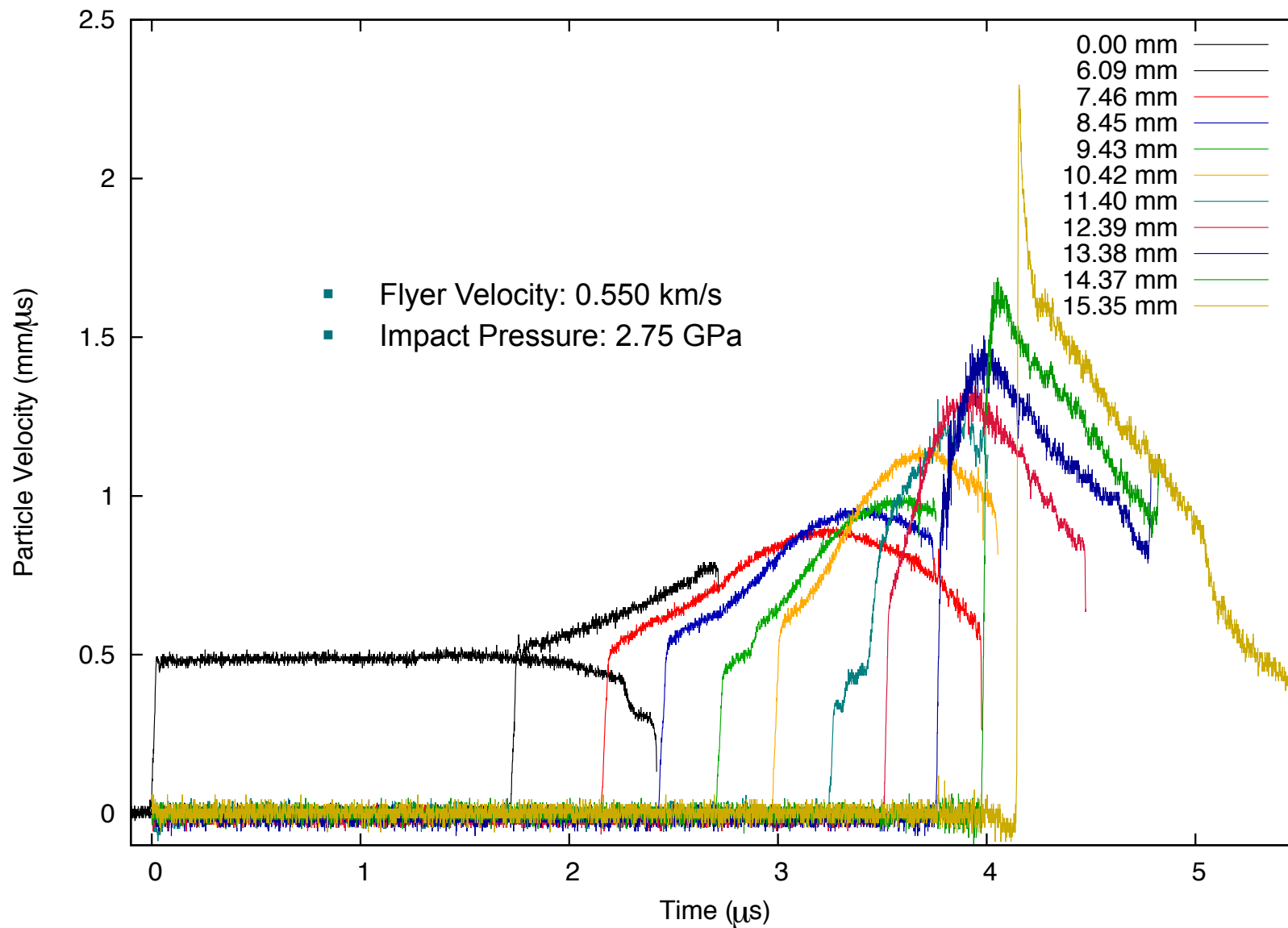


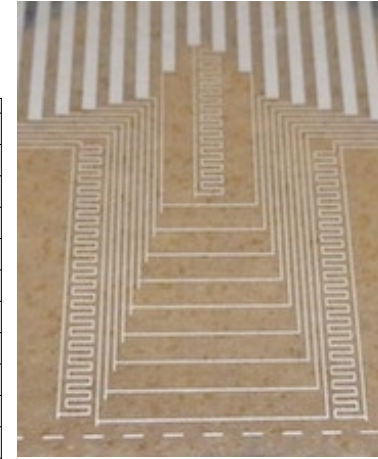
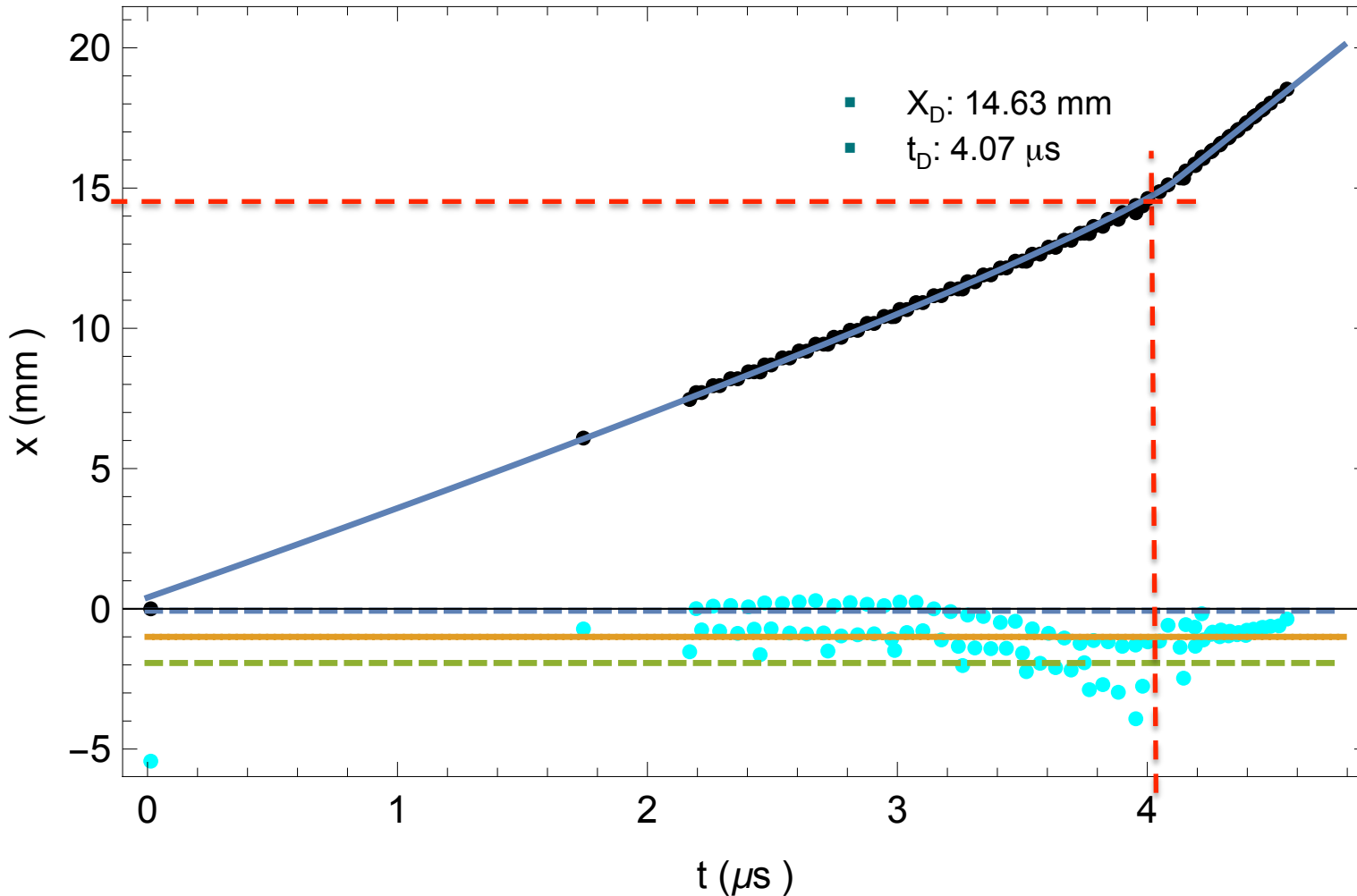
Low pressure

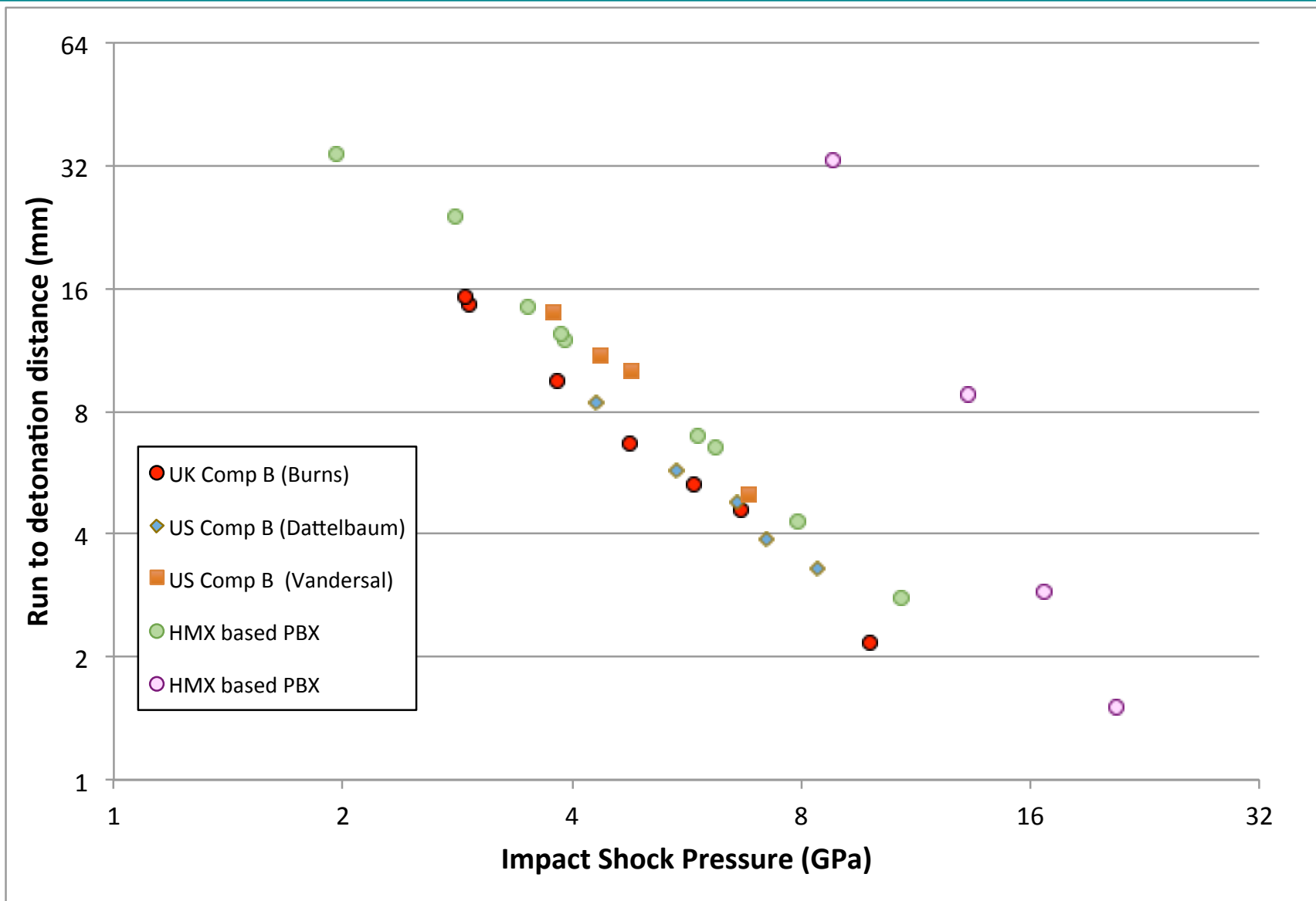
# Shot Hugoniot



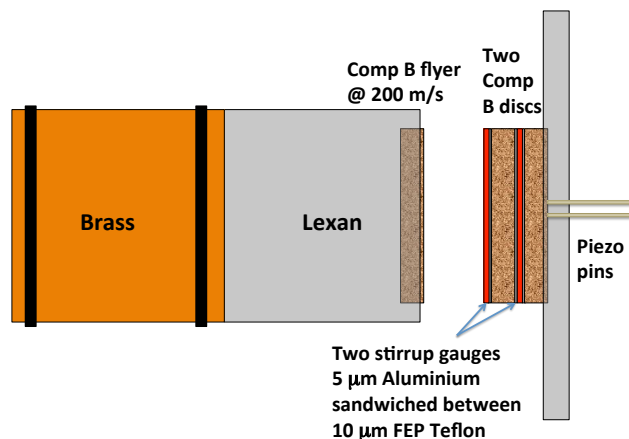
# ‘Typical’ wave profile





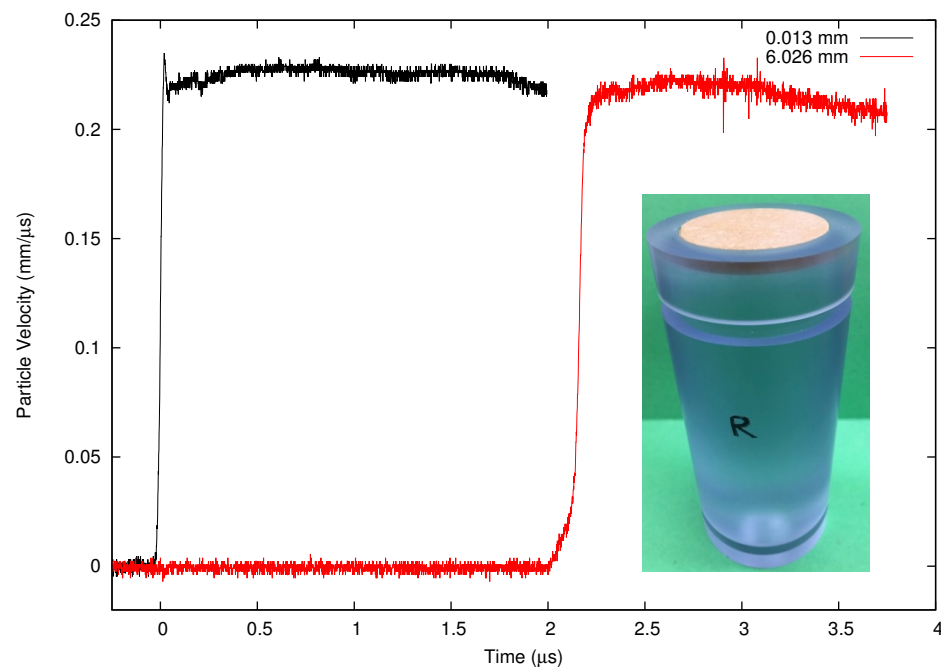
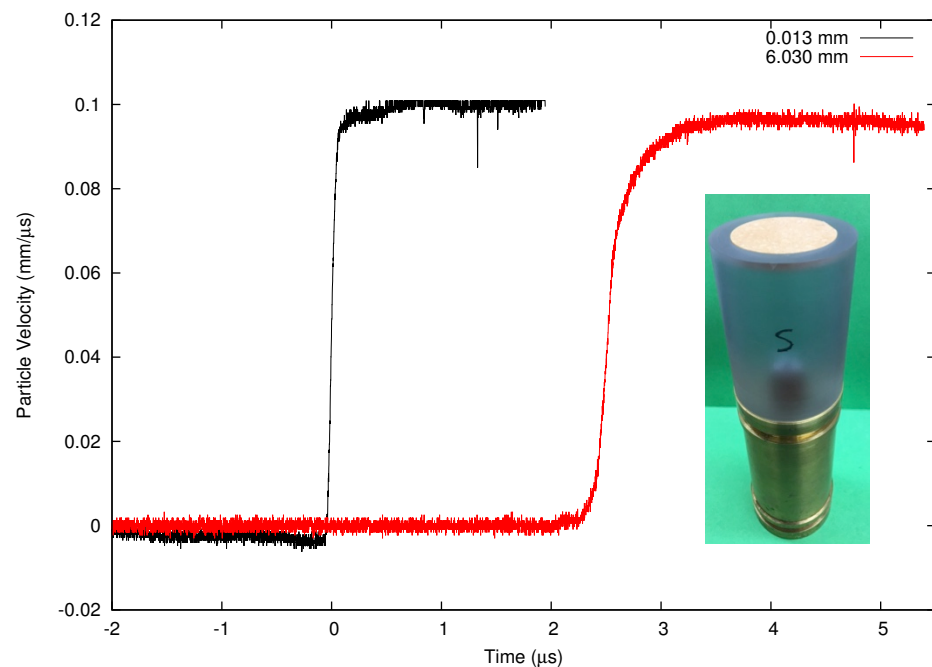


# Low Pressure Shots

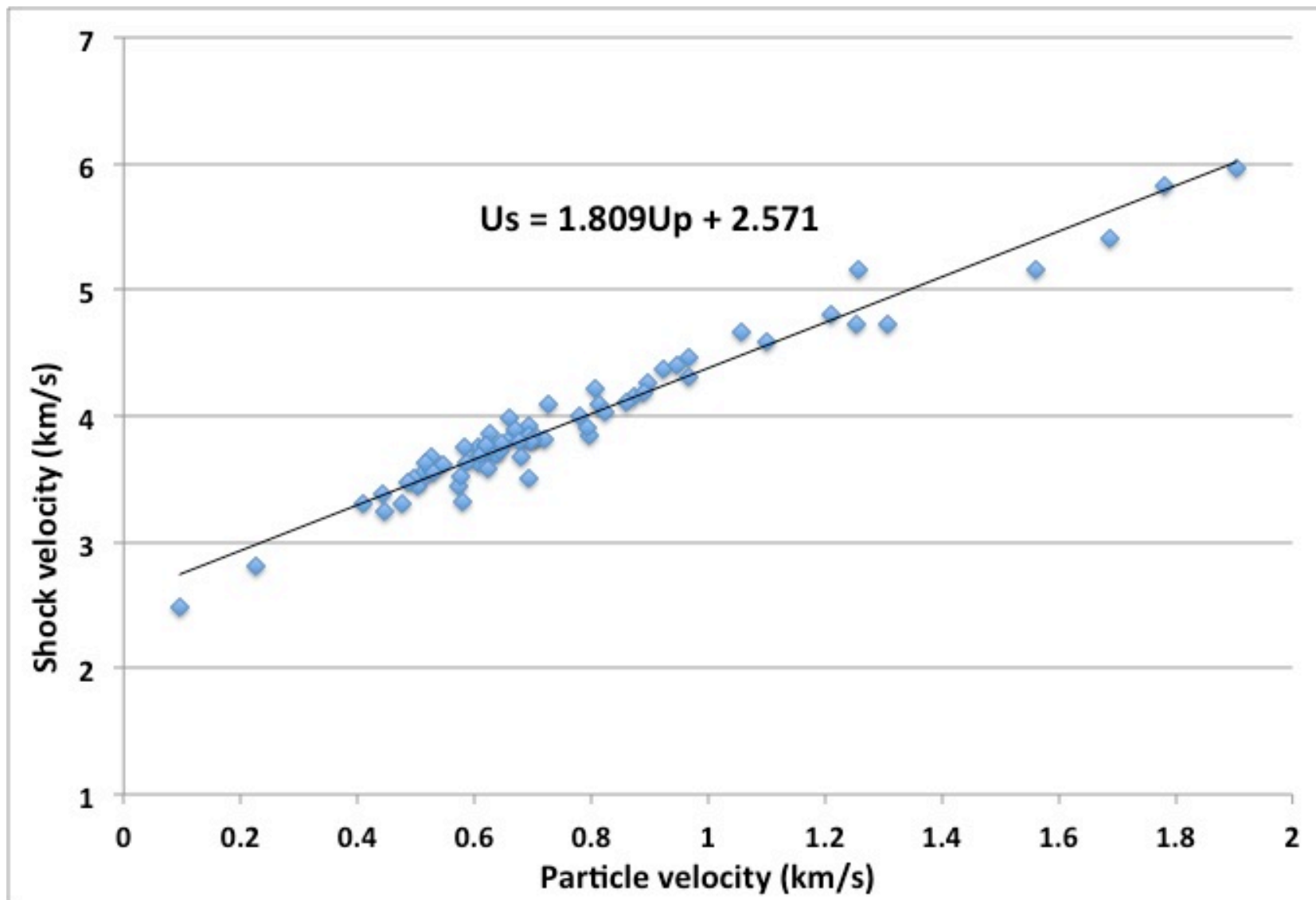


Shot S: 206 m/s, 0.40 GPa

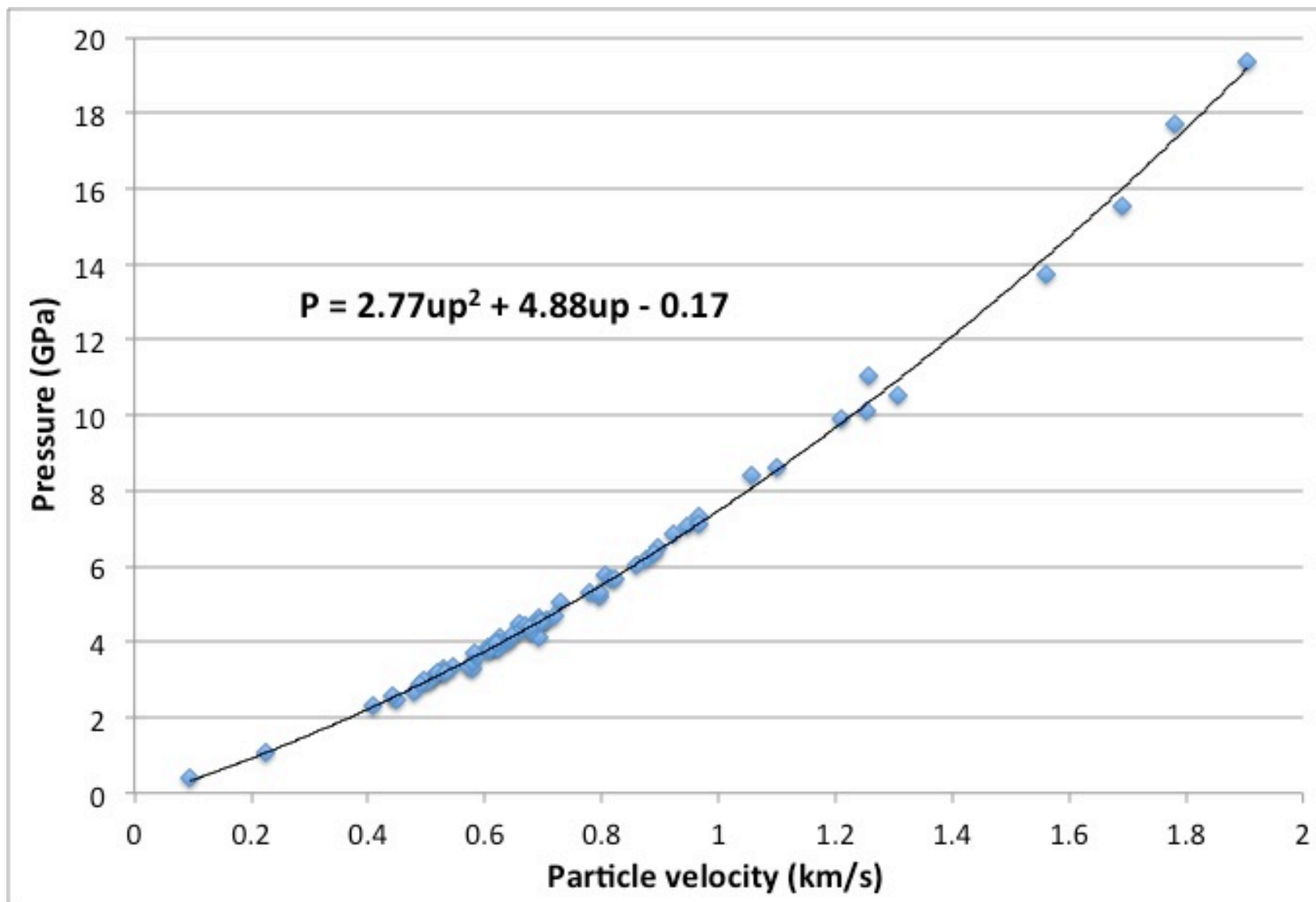
Shot R: 470 m/s, 1.08 GPa

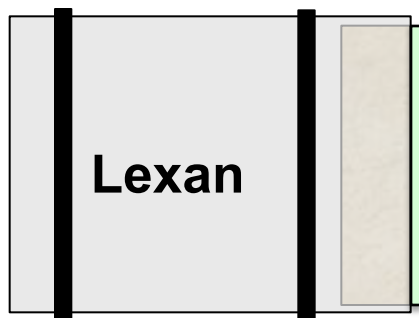
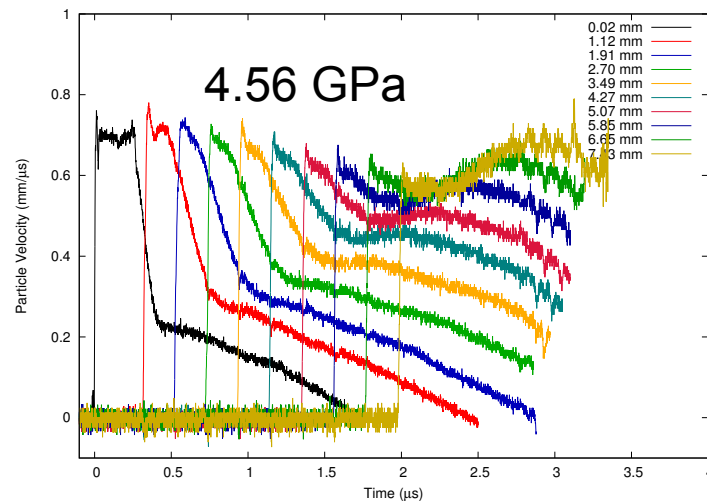
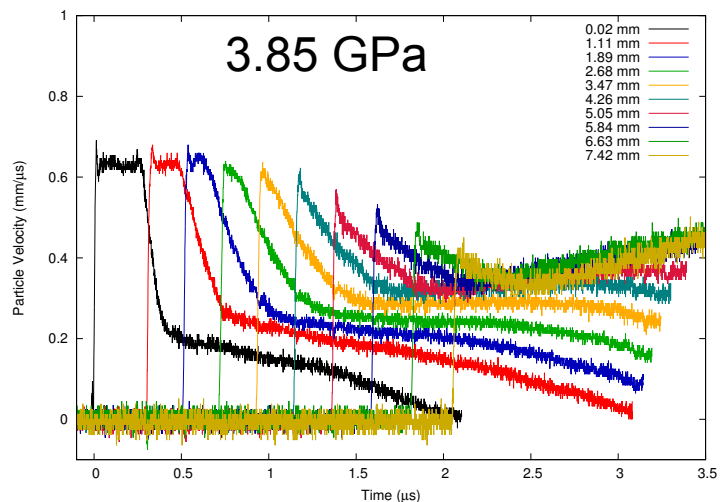


# Hugontiot ( $U_s$ , $u_p$ )

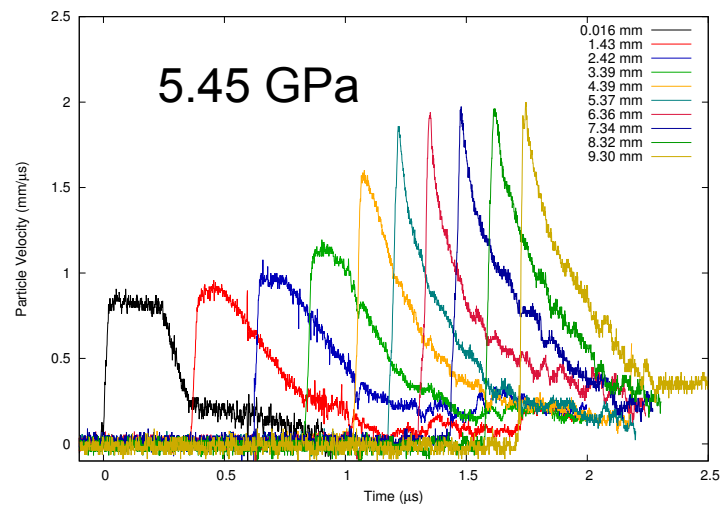


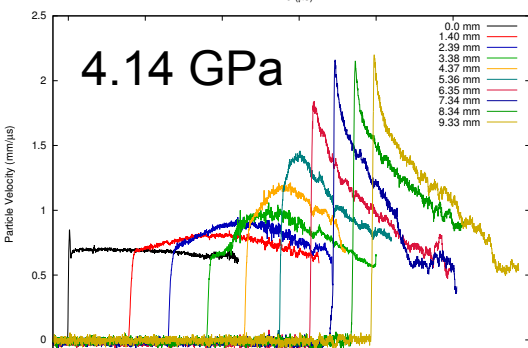
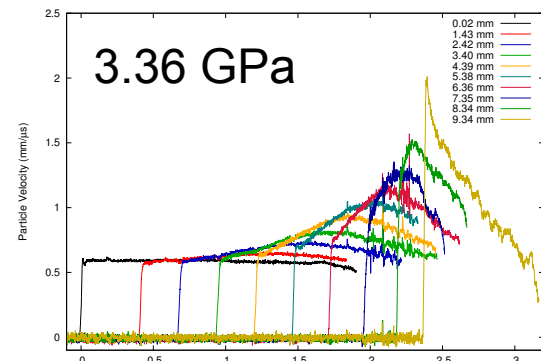
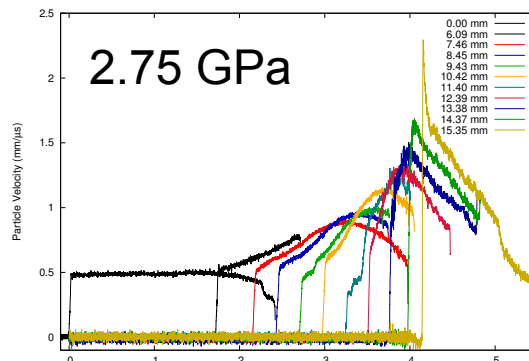
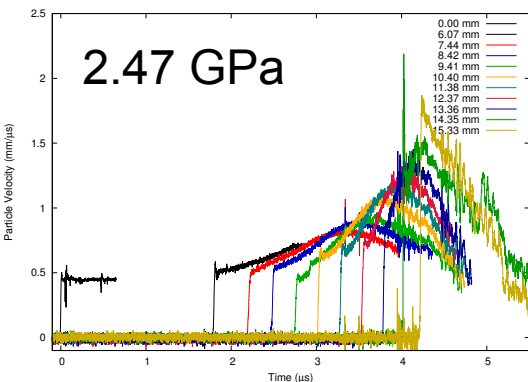
# Hugoniot (P, up)





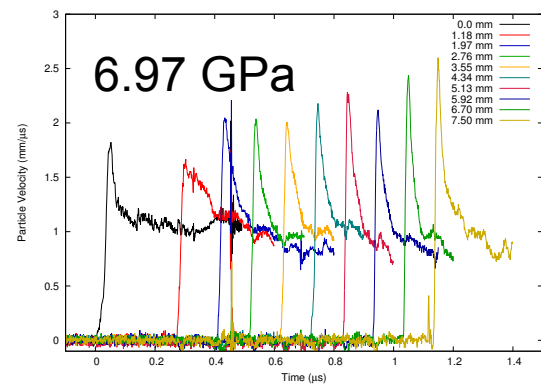
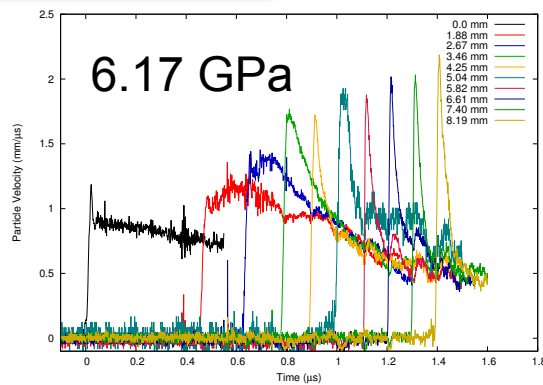
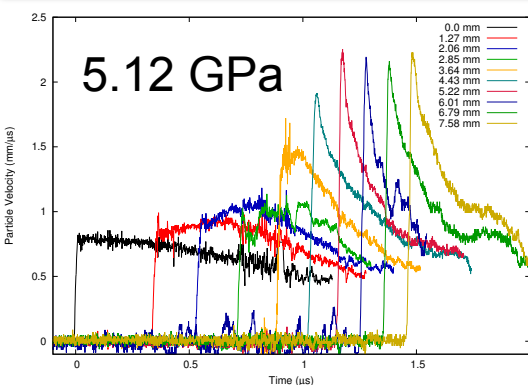
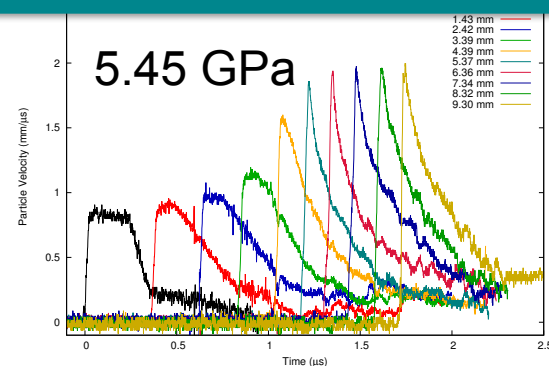
0.5 mm Kel-F  
0.2 g/cc foam



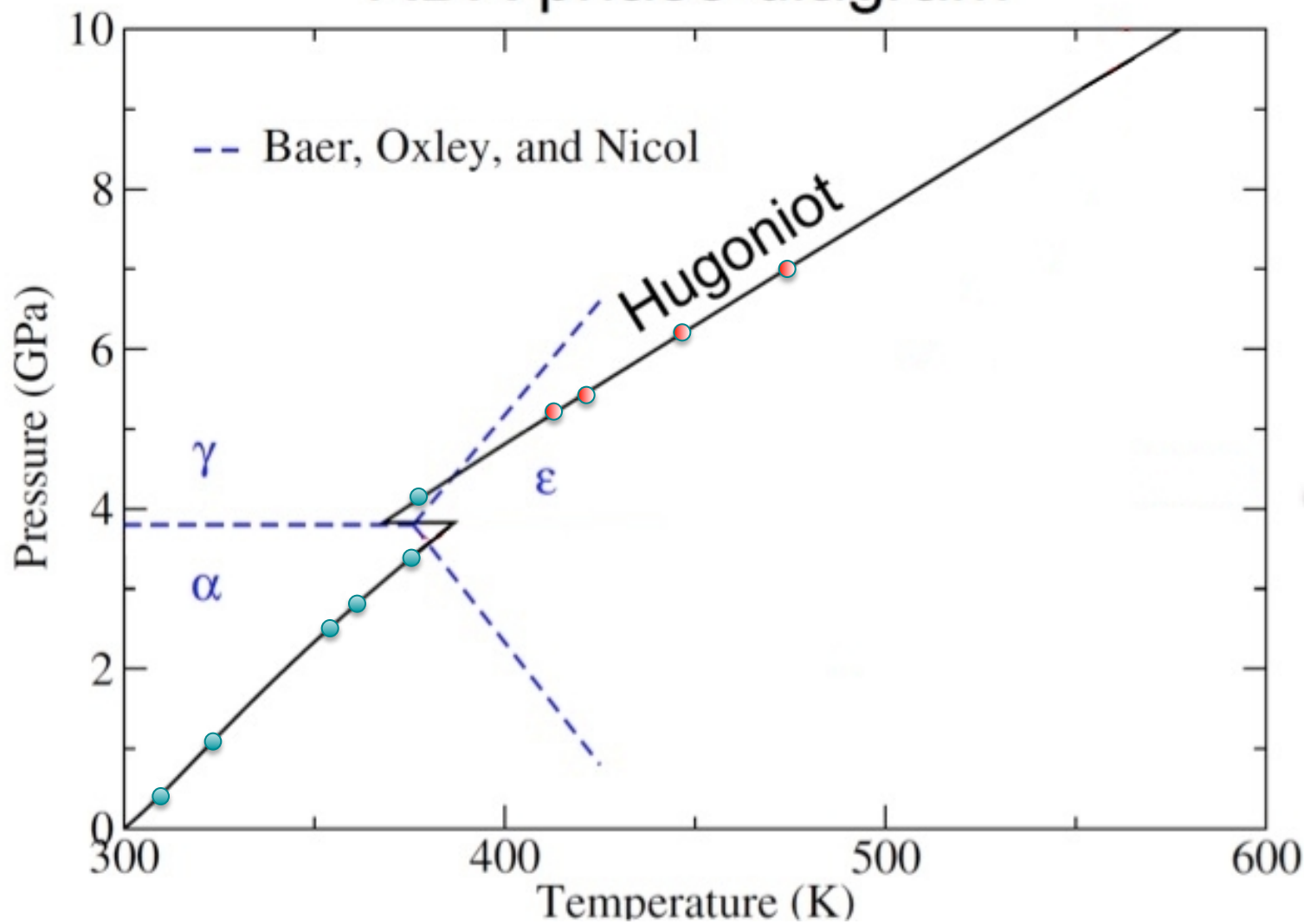


Predetonation noise  
Piezoelectric RDX<sup>#</sup>

RDX  $\alpha$  -  $\epsilon$  phase change



# RDX phase diagram



- Shock initiation of UK Comp B
  - Hugoniot (US-up, P-up)
  - Pop plot
- Piezoelectric effect in RDX
- Data for CREST model

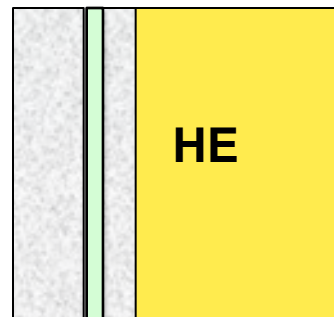
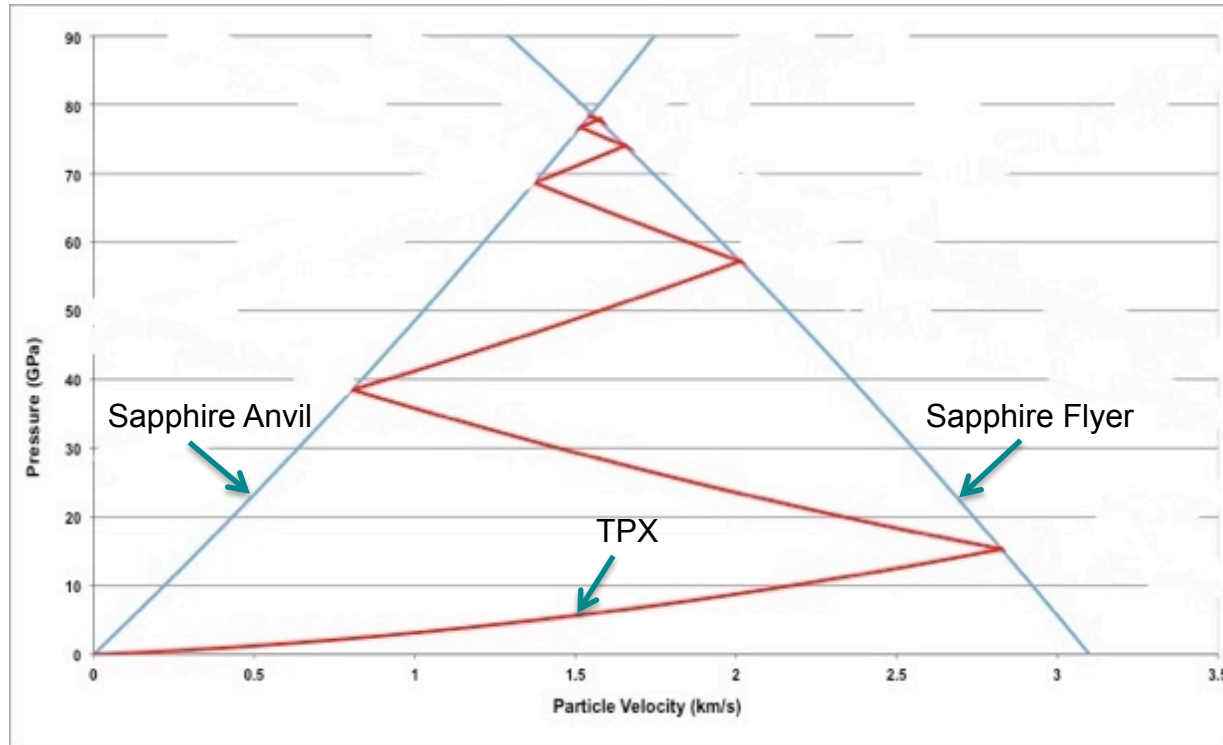
## Future work

- Double shock
  - Straddle the phase boundary
  - Weak first shock – no reaction
  - Stronger first shock – some reaction
- Thin pulse
- Shallow angle
  - 10 degree
  - Short run distance (Pop plot)
- Measuring piezoelectric effect



# Ring up induced shock initiation

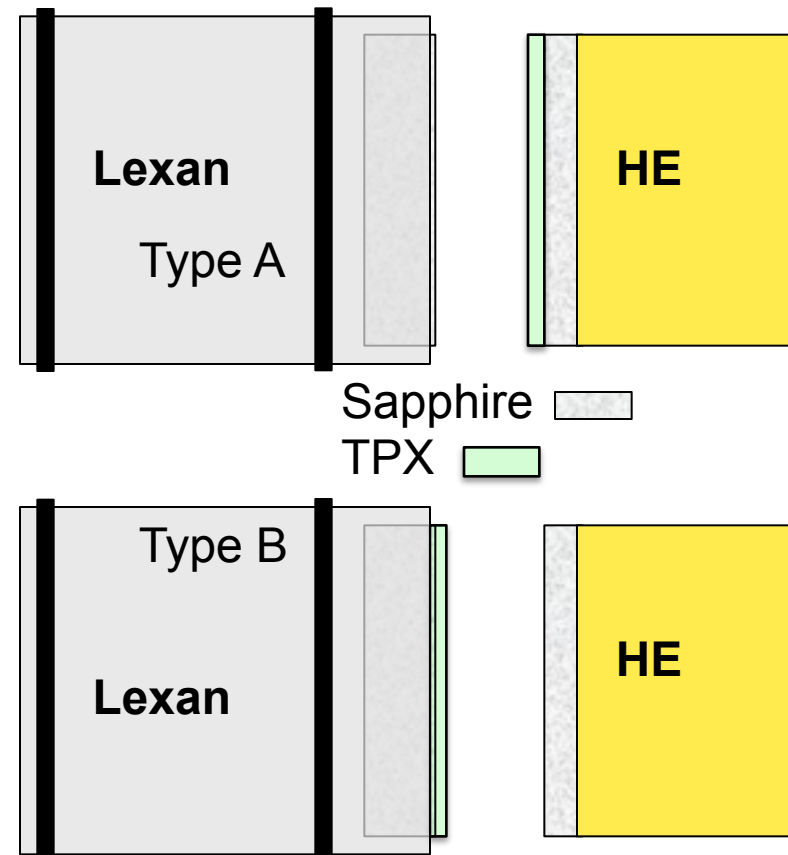
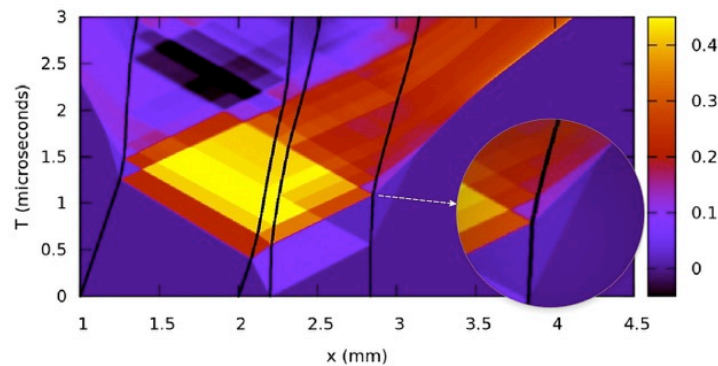
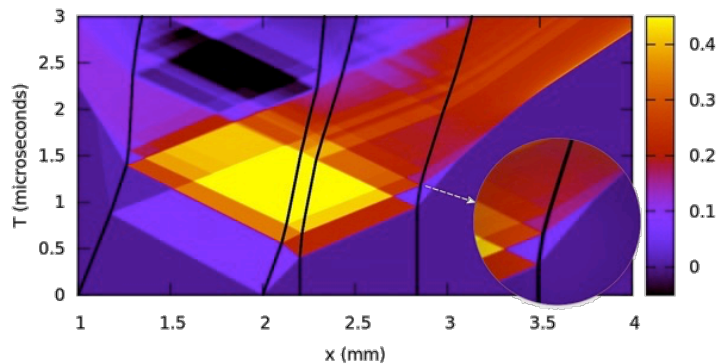
- Common shock initiation scenarios
  - Sustained pulse
  - Double shock
  - Thin pulse
  - Ramp loading
  - Traditional ring up
  
- Alternative shock initiation scenario
  - Using the traditional ring up of a low impedance material between two high impedance anvils
  - Ring up induced shocks into HE sample
  
- Test of reactive burn models such as CREST



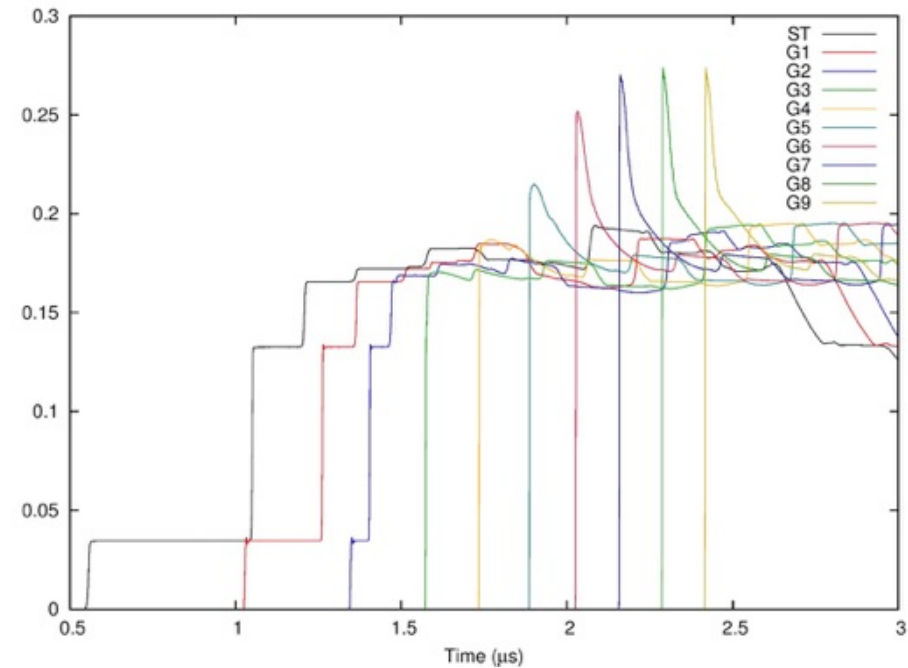
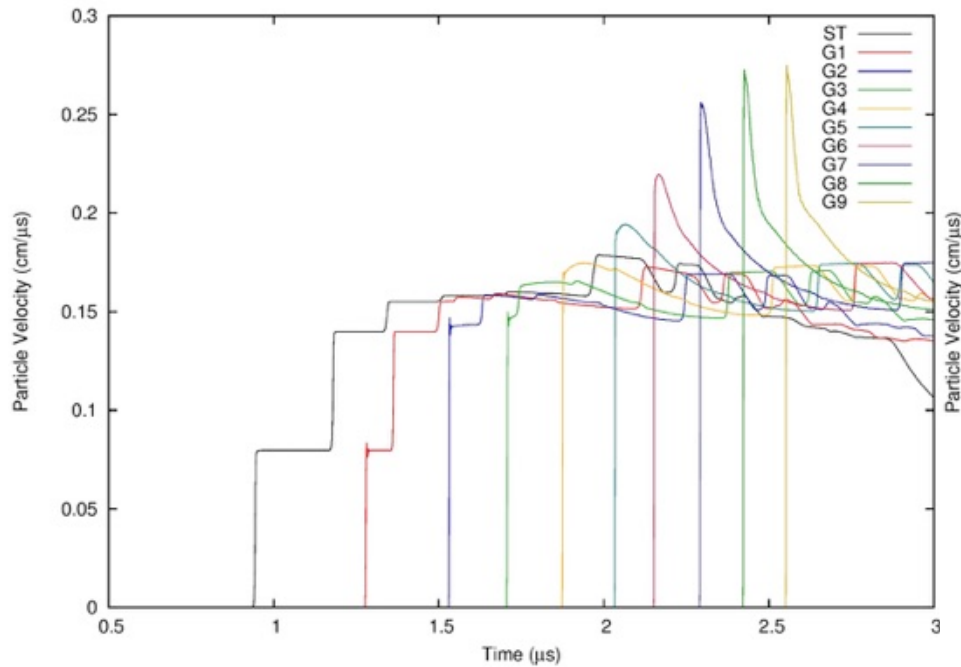
# 1D reactive burn modeling (CREST)

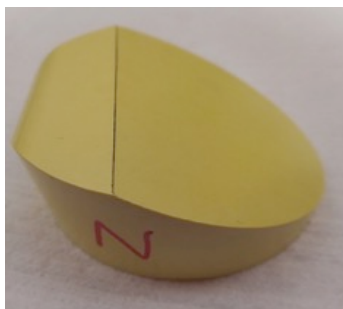
## Modeling experimental aims

- shock loci
- ring duration
- reaction in first shock

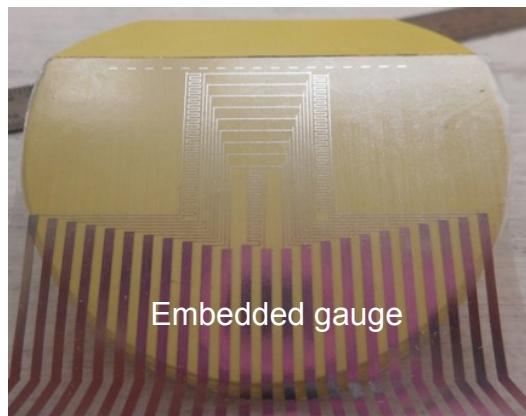


# Particle velocity predictions





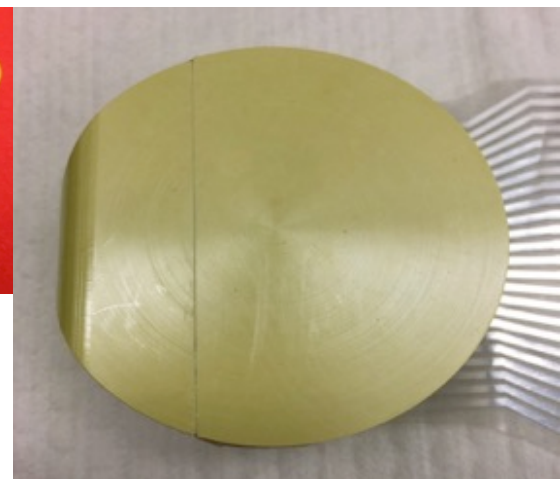
EDC35 Bottom Wedge



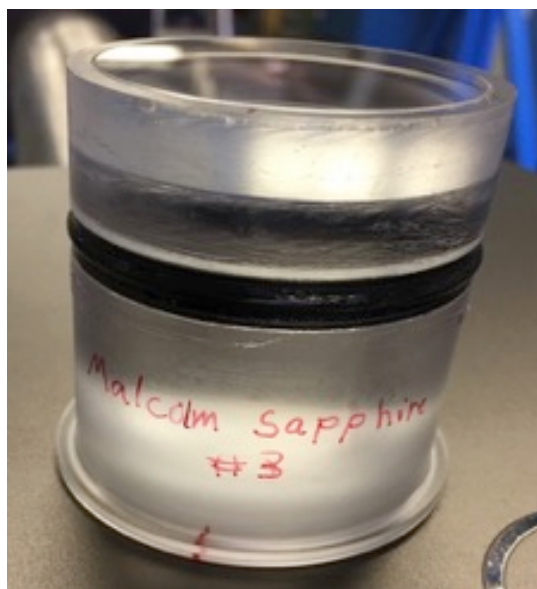
Embedded gauge



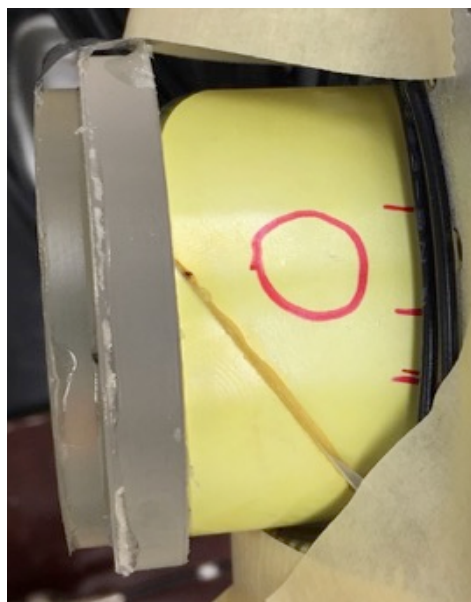
EDC35 Top Wedge



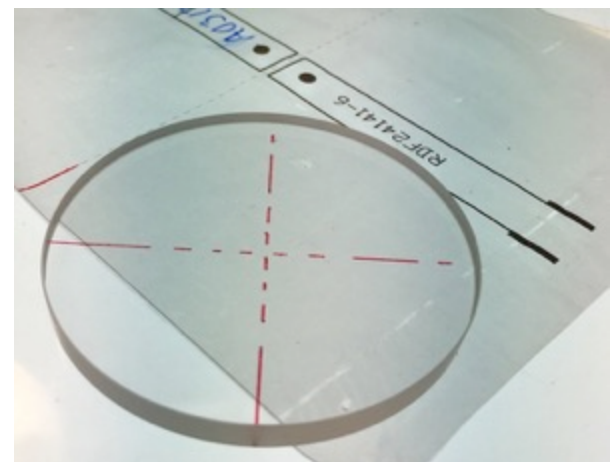
Target post machining



Sapphire flyer



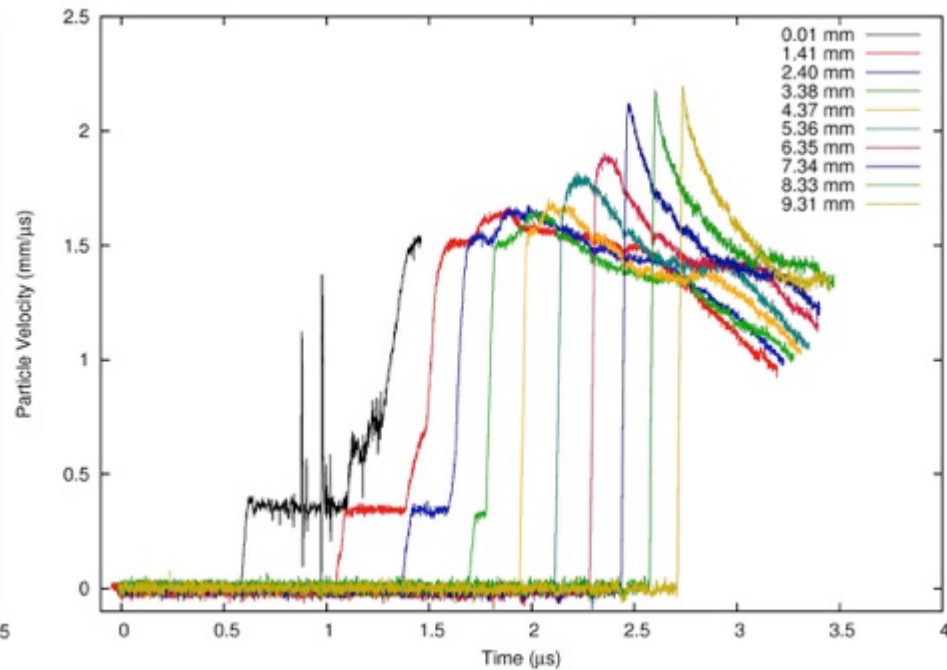
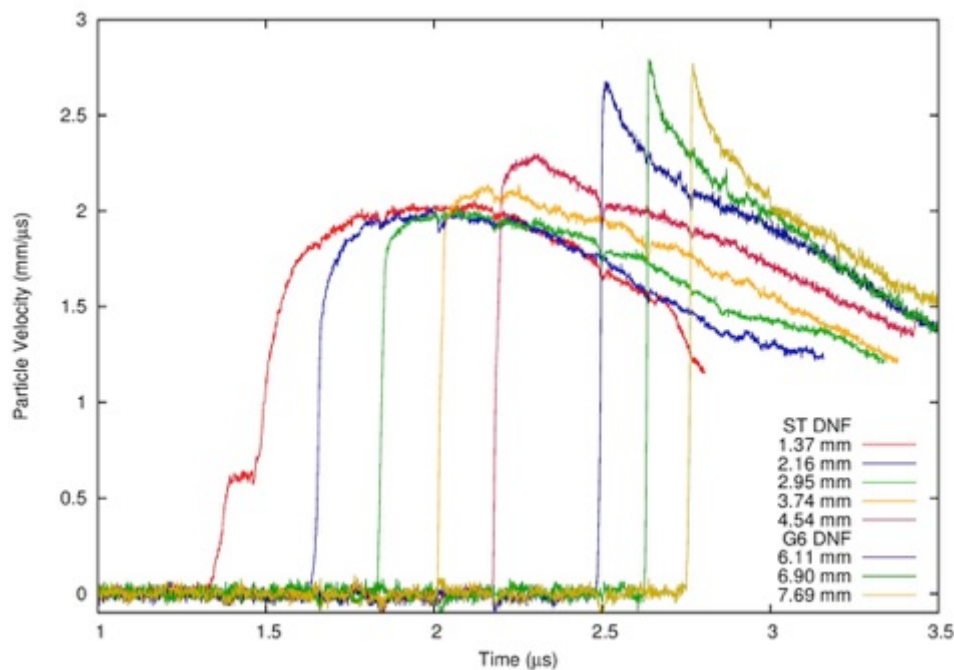
Completed EDC35 target with  
TPX/Sapphire ring up discs



Sapphire disc with stirrup gauge

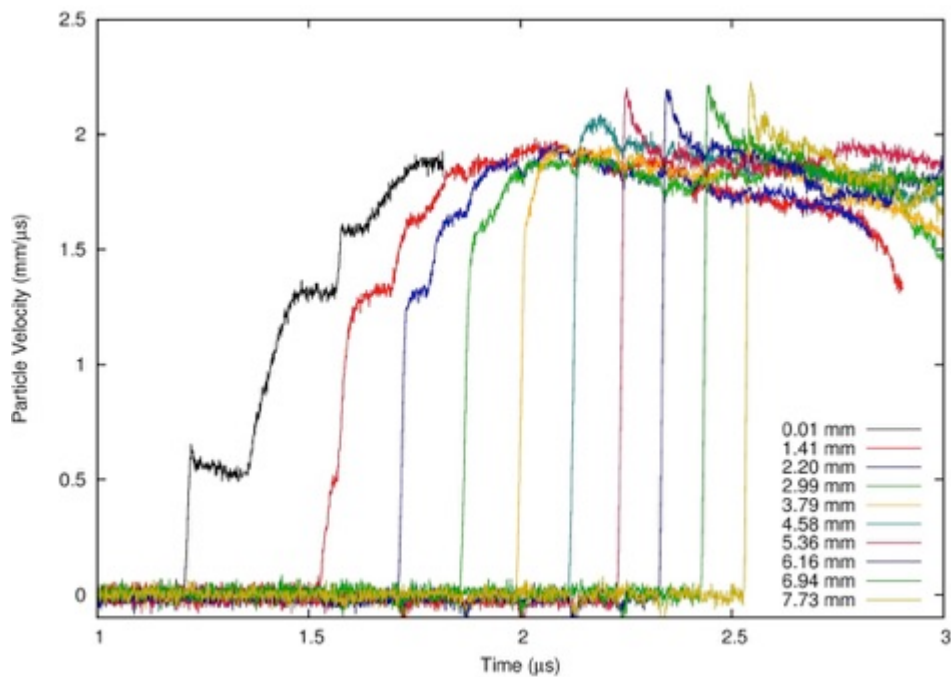
**2 mm TPX on target**  
 $V_p$  2.17 km/s

**2 mm TPX in Projectile**  
 $V_p$  2.21 km/s



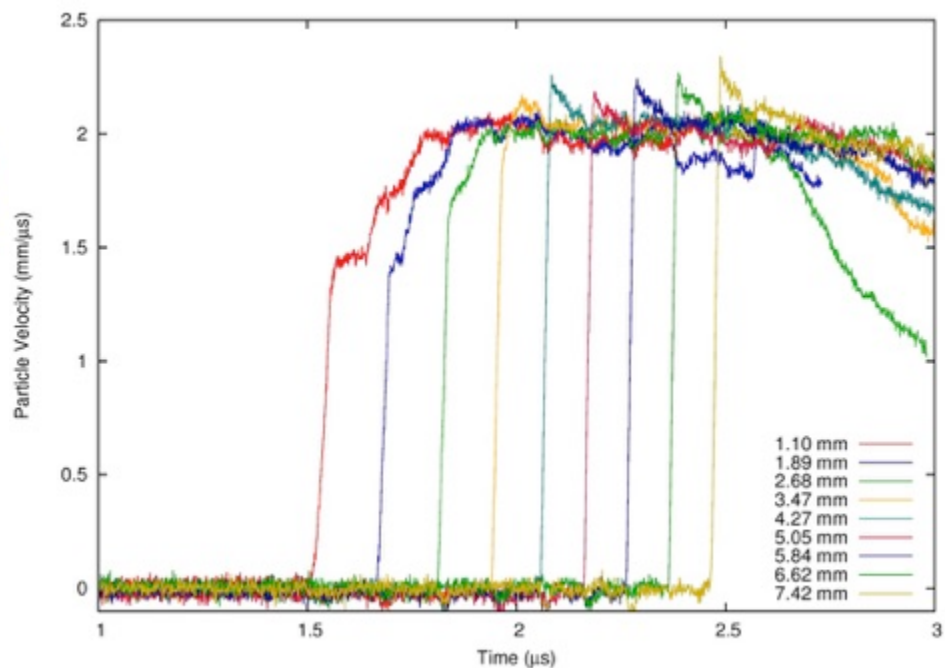
**4 mm TPX on target**

**$V_p$  2.9 km/s**

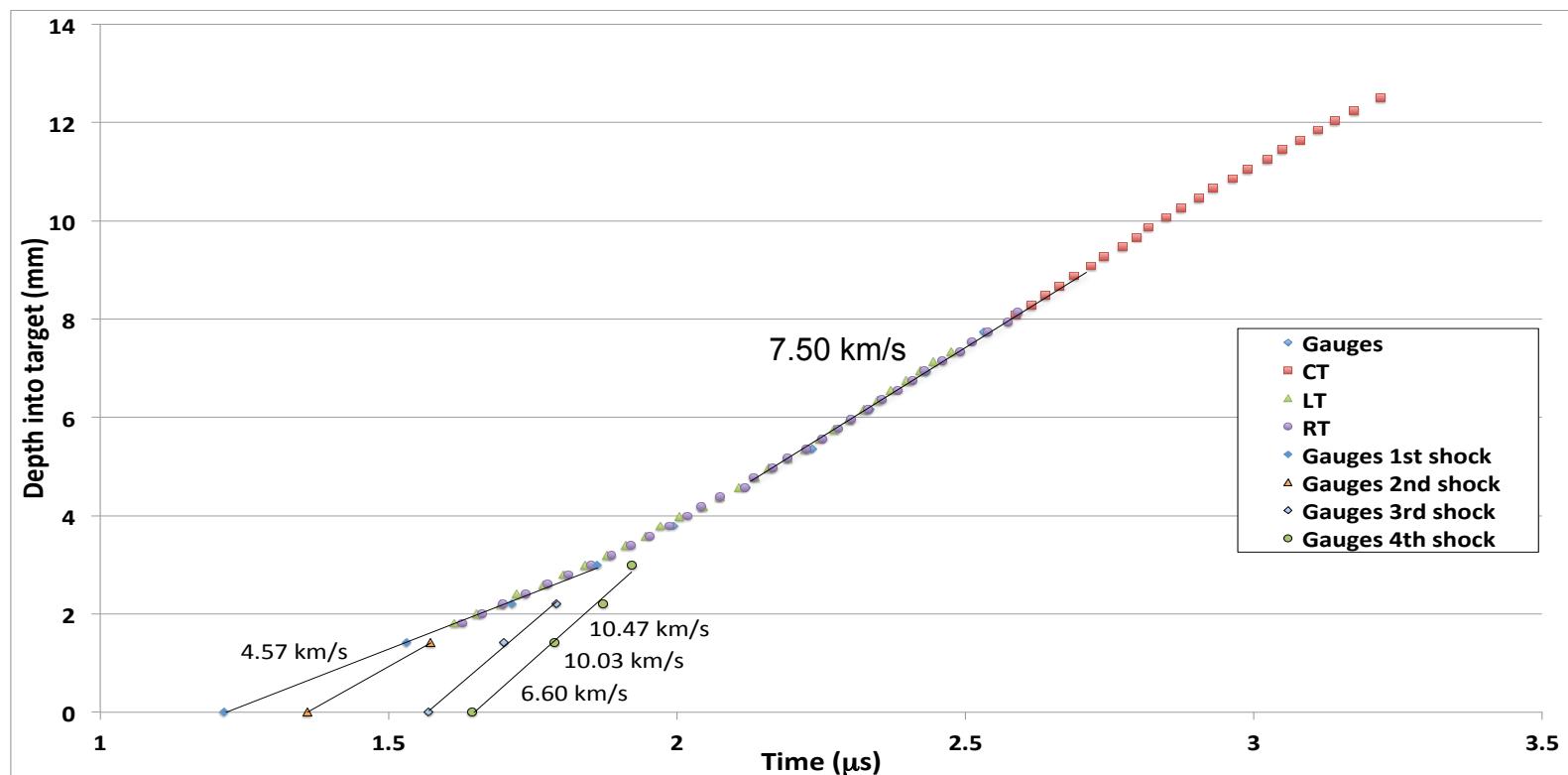


**4 mm TPX on target**

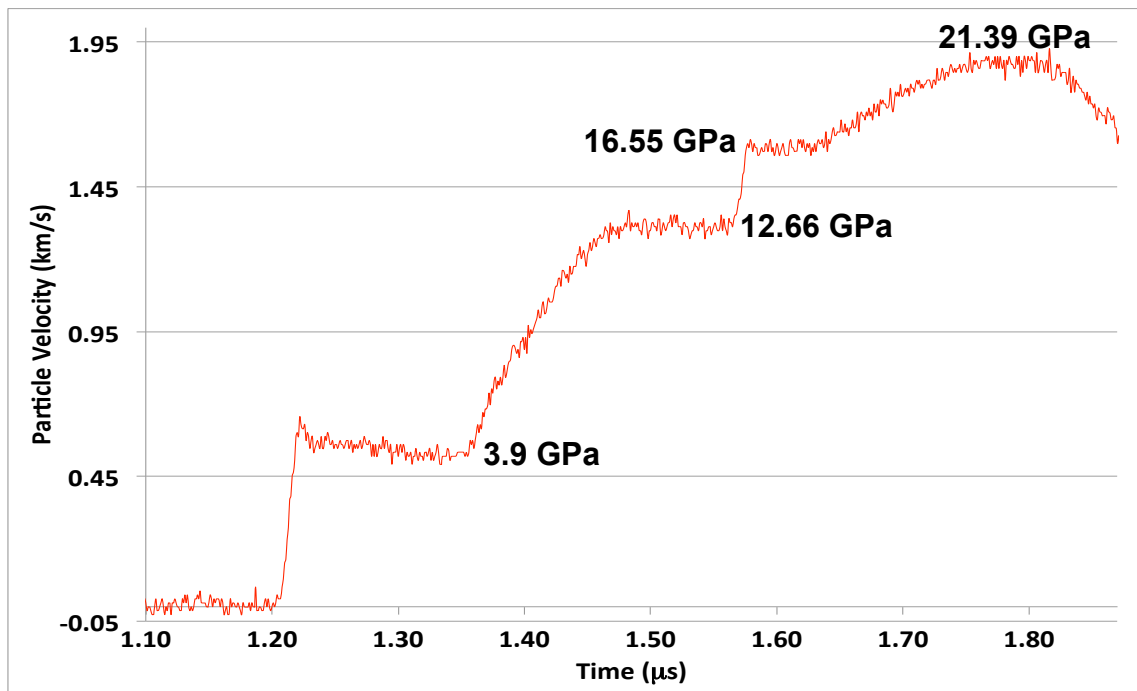
**$V_p$  3.17 km/s**



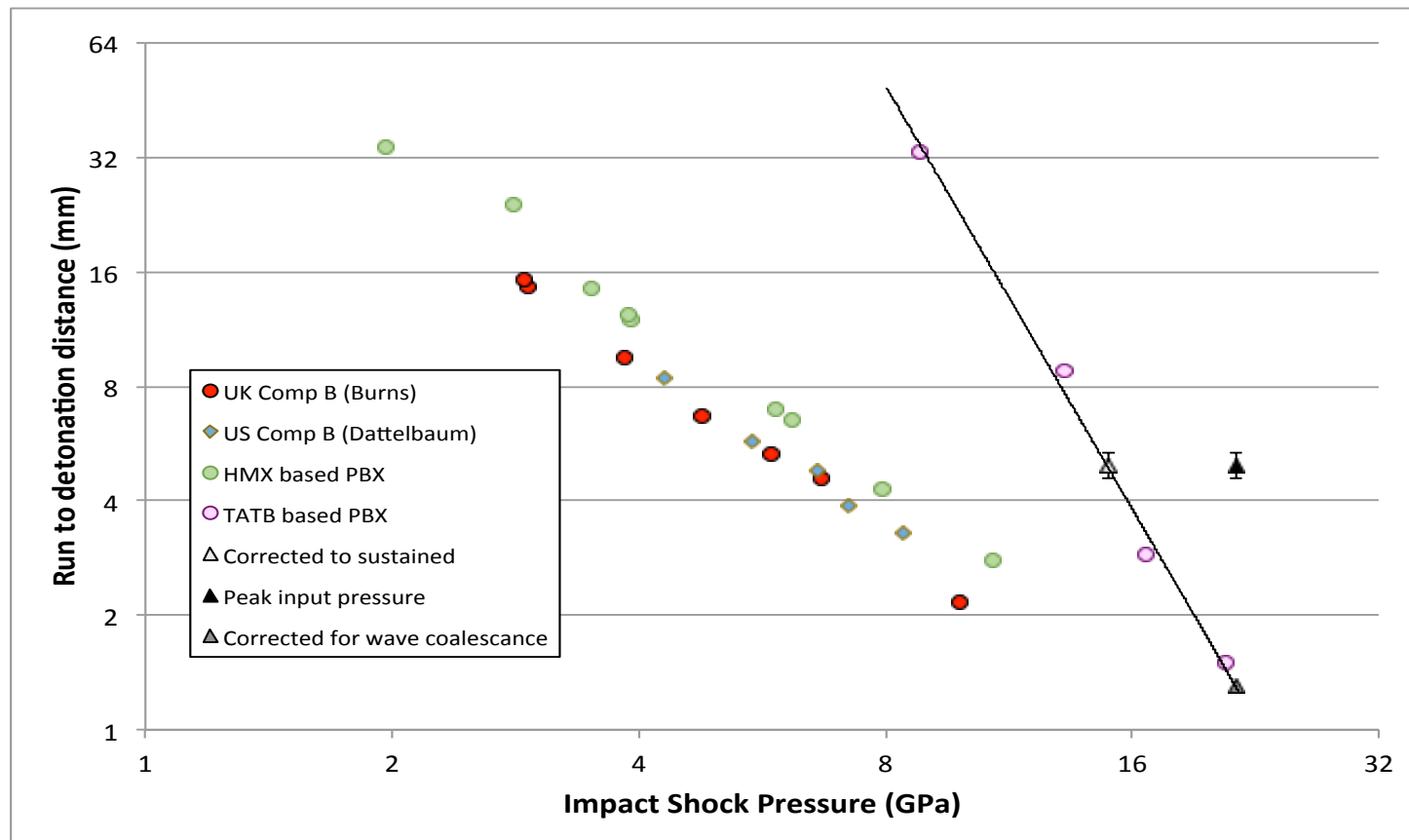
# X-T plot (Shot O)



# Ring up pressure states



- Wave coalescence at 3.68 mm, 2  $\mu$ s
- Detonation at 4.97  $\pm$  0.4 mm
- Detonation occurs 1.29 mm from coalescence
- Fit to Pop plot using distance from coalescence



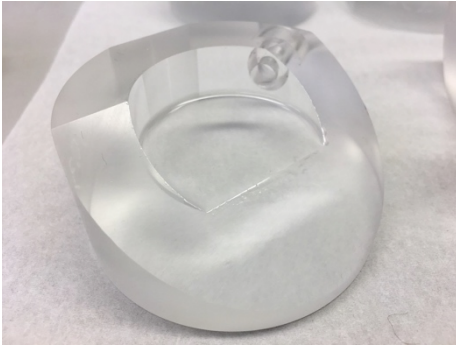
# RUISI Conclusions

- Shock ring-up in a TATB based explosive measured
- Desensitization of explosive observed
  - 21.4 GPa shock = 1.3 mm run to detonation
  - Run to detonation of 4.97 mm equivalent to a 15 GPa shock input
- Fit to Pop plot using distance from coalescence
  - As with double shock experiments

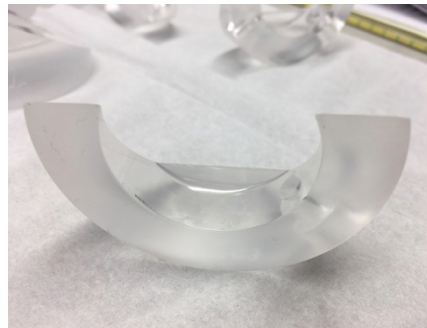
# RUISI Future Plans

- Comparison to a range of reactive burn models
- Comparison to traditional ring up experiments
- Study of ring-up in both CHEs and IHEs
- Improve design to resolve more shocks

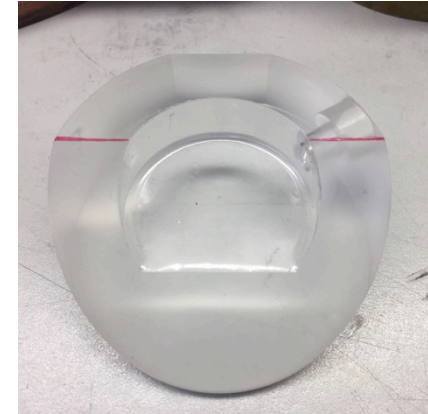
- Nitromethane targets build and ready...



Target bottom wedge



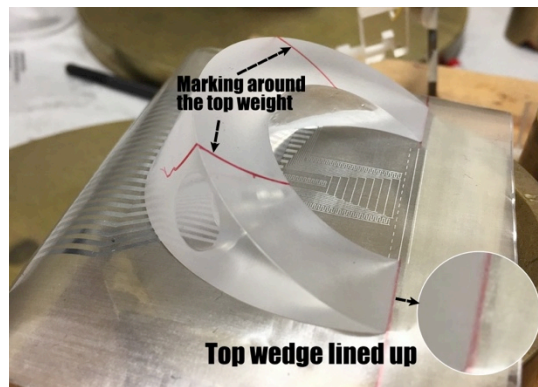
Target top wedge



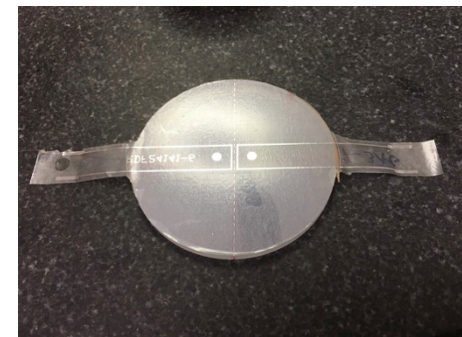
Marked, ready for gauge



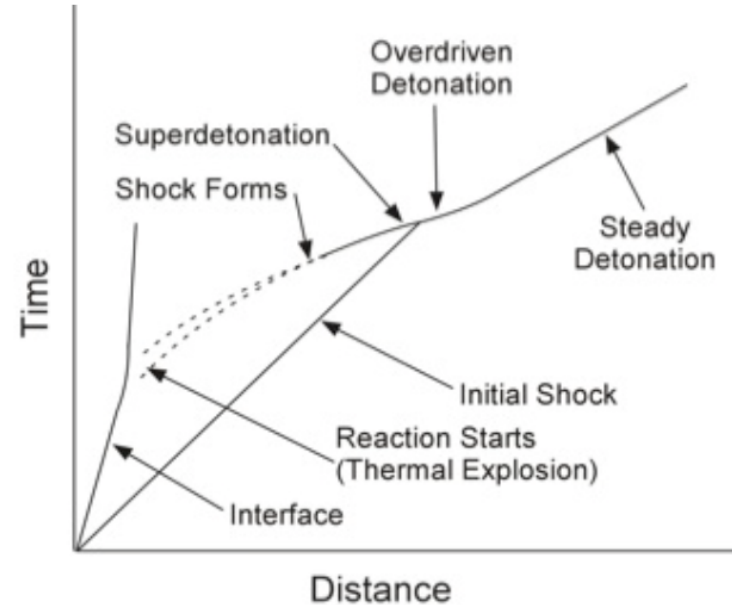
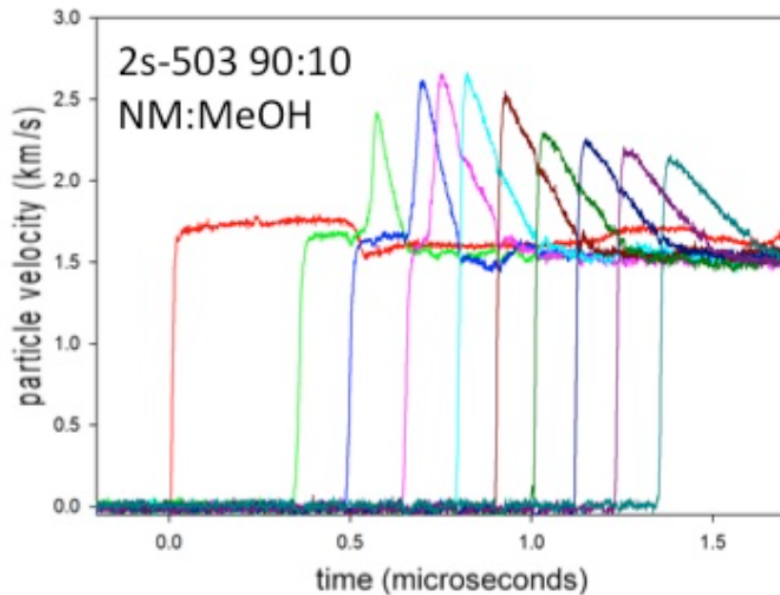
Gauge stretching



Top wedge glued



Lid with stirrup gauge

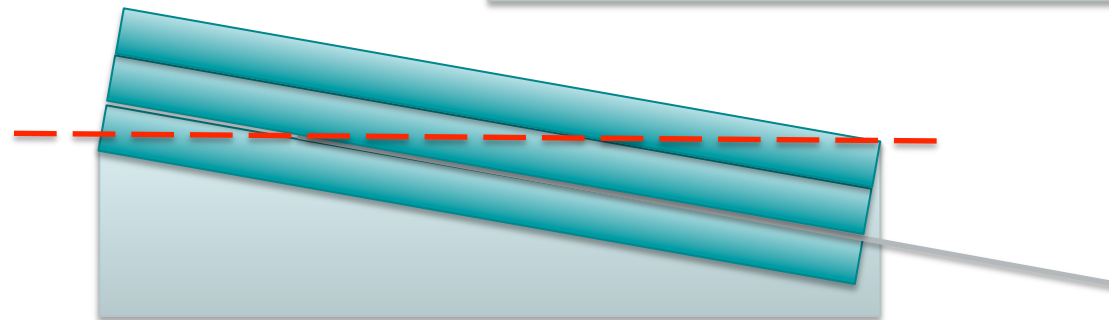
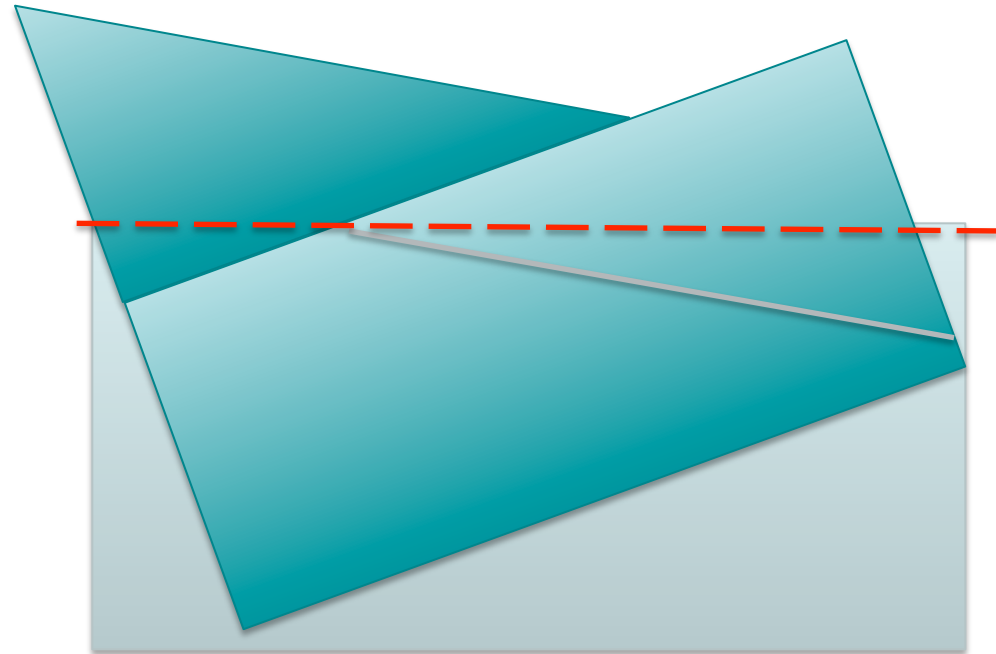


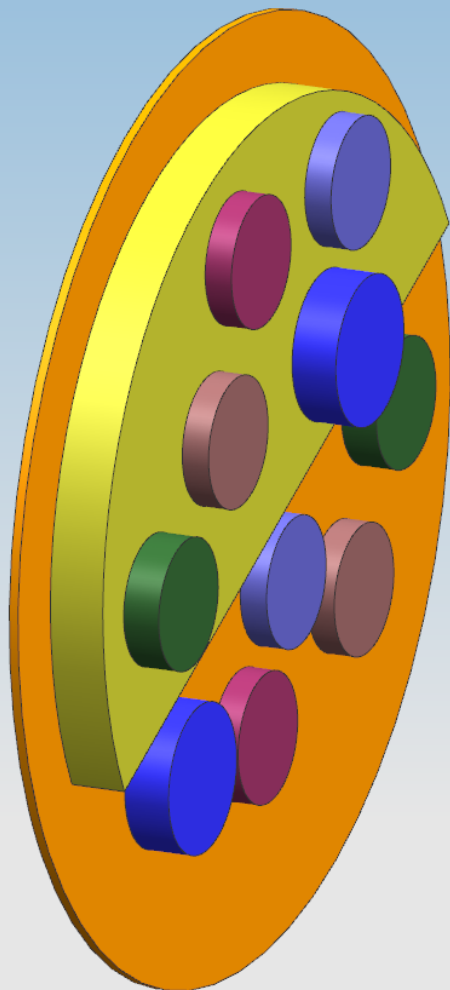
- Measuring superdetonation velocities
  - Microwave Interferometry
- Superdetonation decay to steady state
- Comparison with overdriven

D M Dattelbaum, S A Sheffield, B D Bartram, L L Gibson, P R Bowden and B F Schilling, *The shock sensitivities of nitromethane/methanol mixtures*, Journal of Physics: Conference Series, Vol 500, Part 18.

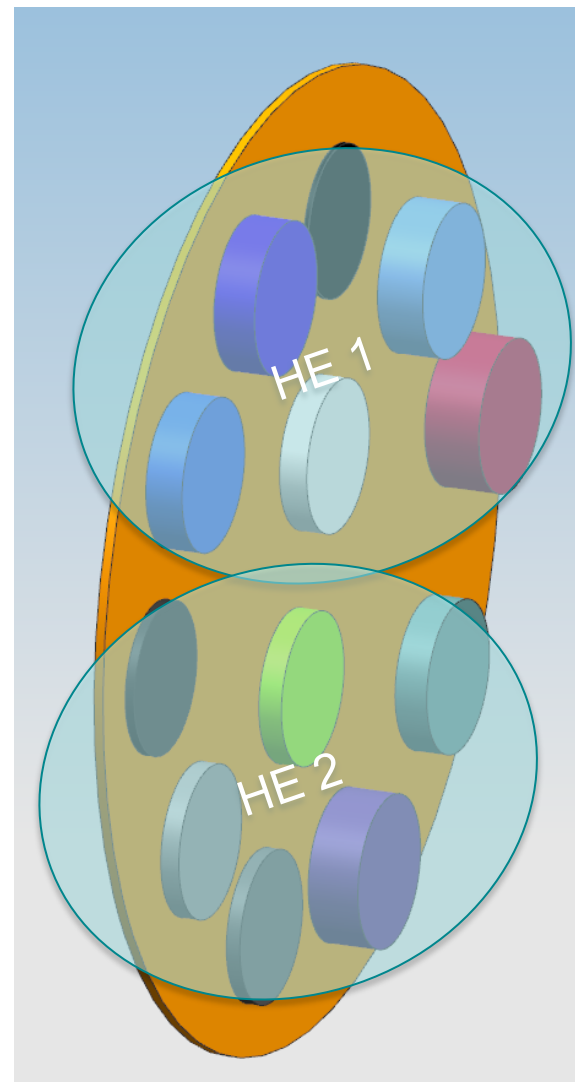
# YEAR TWO

- Doing what you can with the left overs...
- 10° wedges
- Very short run distance
  - 4 gauges <1mm
  - 10 gauges in 2.6 mm
- EDC29 x1
- EDC31 x1
- EDC32 x1
- EDC35 x3





- EDC31, EDC35, EDC37
- Ta flyers
- Cu, Ti cover plates
- Overdriven x 4
  - 0.5 to 6 mm range
  - 500  $\mu\text{m}$  spacing
- Short run distance x3
  - 0.15 to 1.5 mm range
  - 250  $\mu\text{m}$  spacing
- PDV (14 channels)



# Acknowledgements

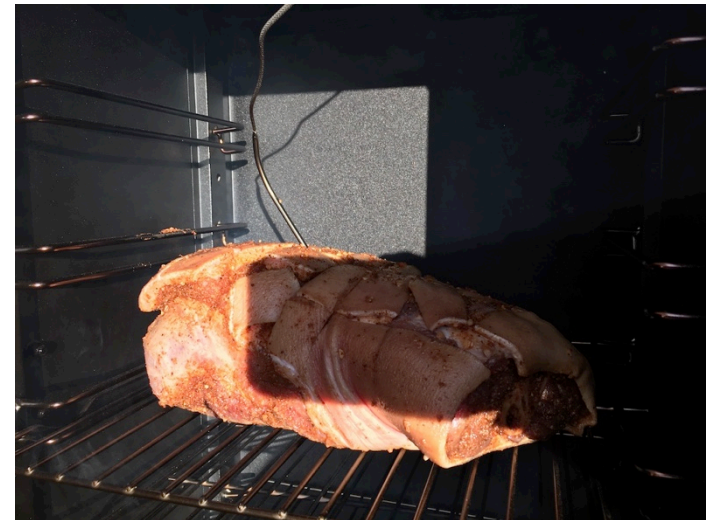
- LANL
  - Rick Gustavsen, Lee Gibson, Brian Bartram, Justin Jones, Austin Goodbody, John Lang
  
- AWE
  - Nick Whitworth, Caroline Handley, Brian Lambourn, James Ferguson, Paula Rosen



Truckin'



Deep frying turkey



Schmokin' a joint (pork)

# Any questions?

